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SURGERY, GYNECOLOGY AND OBSTETRICS

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PARASTERNAL INVASION OF THE THORAX IN BREAST CANCER AND ITS SUPPRESSION BY THE USE OF RADIUM TUBES AS AN OPERATIVE PRECAUTION[1]

BY W. SAMPSON HANDLEY, M.S., F.R.C.S., F.A.C.S., (HON.), LONDON, ENGLAND
Surgeon to the Middlesex Hospital

THE key to further advances in the operative treatment of malignant disease is not to be found in statistical studies in which large numbers of cases are superficially studied often at second hand in the light of existing knowledge. It is in the ward and laboratory rather than in the bureau of health statistics that the information we require is to be sought.

The present paper aims at showing that in many cases of breast cancer, early invasion of the lymphatic glands lying along the internal mammary arteries takes place at a date prior to operation.

The growth of these microscopic colonies, sometimes after many years of quiescence, falsifies the hope of cure. Nodules of growth at the inner end of the upper intercostal spaces, or a lump in the sternum ultimately make manifest the latent process. I shall endeavor to show that by an intelligent appreciation of this danger and by the use of proper means to deal with it in its earliest stage a further improvement in operative results can be attained.

In 1911, Halstead in a masterly paper showed that in breast cancer, if the disease is attacked before the axillary glands are involved, 2 cases out of 3 can be cured, while if the axillary glands are demonstrably cancerous, 3 out of 4 patients ultimately succumb to the disease.

During the 4 years (1920–1923) I operated upon 77 cases of breast cancer at the Middlesex Hospital. Only 20 of these cases were free from axillary involvement, and of these 20, 16 remain well from 3 to 6 years later, 1 died of pneumonia 3 years later, 1 died 2 years after operation of an unknown cause, 1 died as the result of the operation, and one cannot be traced. Thus in the early stage of the disease, operation is successful in 85 per cent of cases. On the other hand, of 24 cases in which the disease though still operable had involved the axillary glands, only 3 are alive and well at present 3 to 6 years later. The remaining 29 cases were frankly palliative operations for very advanced growths. Forty-five per cent of all the operable cases, or 47 per cent if the case of death from pneumonia is counted as a non-recurrence, remain successes from 3 to 6 years later.

The results in the early cases show a definite improvement on Halstead's, the ratio of successes having gone up from 2 of 3 to 4 of 5. To what is this improvement due? It may be reasonably attributed to the fact that during the last 6 years I have inserted radium tubes as a prophylactic in nearly every primary breast operation. My standard procedure is

[1] Read before the Clinical Congress of the American College of Surgeons, Montreal, 1926.

to insert four 25 milligram tubes, screened by 1 millimeter of platinum, in the following positions, one tube at each place, for 24 hours (Fig. 1):

1. Above the first rib, internal to the subclavian vein, in the position of the terminal portion of the main lymphatic duct, whether right or left. This tube lies close to the gland at the lower and inner angle of the posterior triangle, the gland in which supraclavicular recurrence first shows itself.

2. At the inner end of the first intercostal space, buried in the intercostal muscles.

3. At the inner end of the second intercostal space.

4. At the inner end of the third space.

Tubes 2, 3, and 4 it will be seen follow the course of the lymphatic trunk which accompanies the internal mammary artery, and lie close to the glands which are contiguous to this artery (Fig. 2).

The placing of these tubes is based upon a close study of the recurrences which took place in a previous series of cases in which the same operation and the same X-ray course was employed but no radium was used.

Local and axillary recurrence were almost absent from the series. These forms of recurrence have been almost abolished by the improved technique of the modern operation, which takes account of the centrifugal spread of the disease by permeation of the lymphatic plexus of the deep fascia. It is a great satisfaction to me that the permeation theory of dissemination obtained the support of Professor Halstead's authority, and that in order to meet the pathological requirements he altered his operative method and began to practice extensive undermining of the skin flaps, a step which he had not previously considered necessary.

Although the modern operation suppresses local recurrence, and so keeps the patient active and happy until near the end, it generally fails in the long run to cure the disease if the axillary glands are already affected.

The enlargement of the axillary glands I believe is not in itself the lethal factor, for recurrence in the axilla after an efficient operation is very rare. It is, however, an index to another and more subtle mode of invasion, to which I desire to direct your particular attention. I believe that by the time the axillary glands are enlarged, the disease has frequently, and perhaps usually, obtained access through the inner ends of the intercostal spaces to the internal mammary glands, and that in quite early and still operable cases these glands contain microscopic deposits of cancer cells.

What is the evidence for this belief? It is the fact that in more than half my recurrent cases, before I began the prophylactic use of radium, the return of the disease manifested itself either by an enlargement of the gland at the lower and inner angle of the posterior triangle, or by the appearance of nodules, later merging in sternal recurrence, upon the deep fascia at the inner end of the first, second, or third intercostal spaces. The position of these recurrences accurately along the line of the internal mammary artery shows I think beyond doubt that they are due to invasion of the lymphatic glands which lie along its course.

To excise these glands is possible; I have done it in 5 cases, but it makes the operation too long and severe. On the contrary, to bury radium in them, or close to them, is quite easy and does not prolong the operation more than 5 minutes. The procedure does not increase the risk of the operation. In 2 or 3 cases it has led to a small pneumothorax, but only one of these cases gave rise to anxiety, and the patient recovered. Care must be taken to keep the tubes at least half an inch beneath the skin, and if a thin skin flap lies directly over one of the tubes that tube should be left in position for a shorter time—say 12 hours only.

I have obtained definite evidence, which I will later produce, that radium tubes used in this way can destroy microscopic and even massive deposits in the internal mammary glands. But it is clear that the use of them is not likely to produce any startling improvement in results. They must be used, if at all, in a routine fashion in every case, for we have no means of telling in a given case whether the glands are or are not affected. In this regard operable cases of breast cancer are divisible into three groups not clinically distinguishable one from the other.

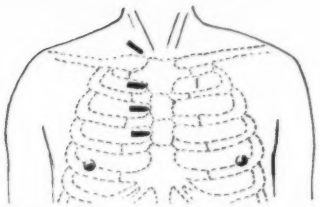

Fig. 1. Showing the portion of the buried radium tubes along the line of the internal mammary glands and the lowest supraclavicular glands.

1. Cases in which the internal mammary glands are not infected at the time of the operation.

2. Cases in which these glands are so infected.

3. Cases in which the glands are infected and in addition the disease has already spread beyond them to other glands within the thorax.

As regards the use of radium tubes in the way I suggest, it is clear that it will produce no improvement of results in Groups 1 and 3. In the first group it is superfluous, in the third necessarily ineffective. The action of radium is local only, and cases in Group 3 will run their course, unchecked by operation, radiation, or any other means at present known. But in Group 2, I believe that the use of radium will make the difference between failure and success. I have had the opportunity of watching for 12 years a case which clearly, at the time of operation, belonged to Group 2.

Five years after I had operated for a carcinoma of the left breast, a little nodule appeared at the inner end of the second left intercostal space. Nearly 2 years later a similar nodule appeared at the inner end of the third space, and 2 years still later one at the inner end of the fourth space. Four months afterward, the fifth space was invaded, and shortly after that the sixth. The disease then spread outward along the fourth and fifth spaces, and finally the opposite breast and pleura were attacked, the patient dying 12 years after operation. The slow descending infection of the internal mammary lymphatic chain is here unmistakable. It seems certain that the gland in the second space was the only focus of disease within the thorax at the time of operation and that if radium tubes had been used at that time the disease would have been permanently cured.

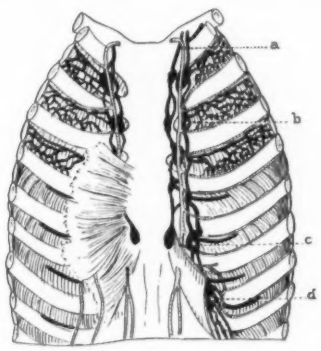

Fig. 2. The internal mammary glands. *a*, Efferent vessel of the internal mammary chain; *b c*, glands of this group; *d*, diaphragmatic gland. (Reproduced from Poirier's *The Lymphatics;* translated by Leaf. Constable, 1903.)

This case is so instructive and it is so difficult to get precise records of clinical history over so long a period as 12 years, that I have thought it worthy of illustration and of detailed record. Incidentally it illustrates perfectly the slow centrifugal spread of the disease along the lymphatic vessels. It also shows that modern methods of treatment, even when they fail to cure, maintain the patient's activity and comfort over a long period of years.

MODE OF INVASION OF PARASTERNAL CHAIN OF GLANDS. EARLIER RECURRENCES SUCCESSFULLY TREATED BY RADIUM AND COOLIDGE X-RAYS

Mrs. S. January 22, 1912. Patient suffered from carcinoma of left breast (Fig. 3), chronic mastitis of right breast. Radical operation was done, the left breast being removed, the lesser pectoral and serratus muscles being left.

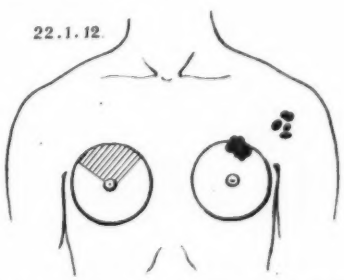

Fig. 3. Chronic mastitis right, carcinoma left breast.

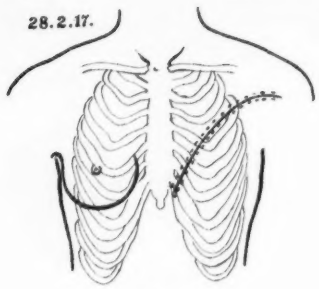

Fig. 4.

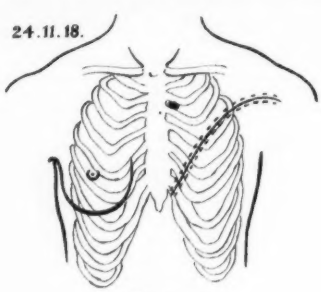

Fig. 5.

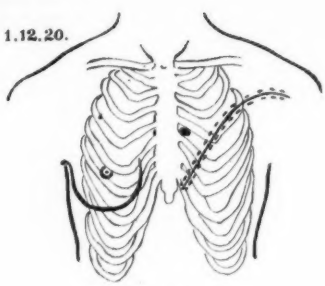

Fig. 6.

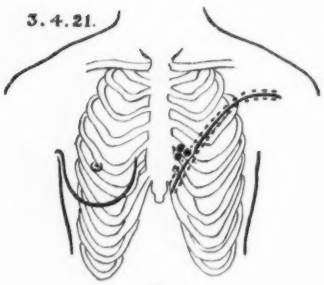

Fig. 7.

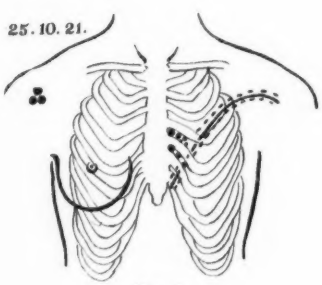

Fig. 8.

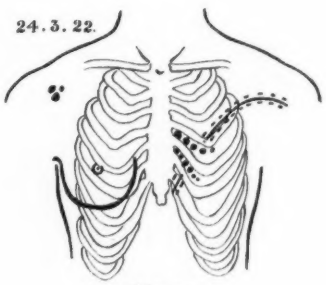

Fig. 9.

July 7, 1912. X-ray treatment given.

April 18, 1914. Examination showed no evidence of recurrence.

February 28, 1917. Nodule has appeared at upper border of the second left costal chondrosternal junction (Fig. 4).

October 18, 1918. The nodule had become larger and was removed.

November 24, 1918. Another nodule appeared in the space below. Radium was inserted into both spaces (Fig. 5).

July 7, 1919. No recurrence is evident. Patient is extremely fit and is driving a car.

December 1, 1920. A mobile nodule is found in the fourth left space and hard glands in the right axilla. Radium was inserted in these two situations. X-ray treatment was given (Fig. 6).

April 3, 1921. Three nodules are seen over the fifth costal cartilage and fifth space. An operation was done and a piece of the fourth costal cartilage was removed and radium tubes were put in the fourth space down toward the ensiform and up under the costal cartilage above (Fig. 7).

June 25, 1921. Radium was applied to surface for 4 hours: 50 milligrams to nodules and 50 milligrams to right axilla.

September, 1921. Coolidge tube X-ray applications.

October 25, 1921. Nodules are present over fourth, fifth, and sixth ribs and the intervening spaces (Fig 8).

March 24, 1922. The subcutaneous nodules are much reduced since the Coolidge treatment (Fig. 9).

June 1, 1922. The superficial nodules are spreading backward along the fourth and fifth spaces and there is median extension toward the ensiform cartilage (Fig. 10). The right axillary glands are larger and a line of nodules has appeared along a main axillary lymphatic vessel. Coolidge tube X-ray treatment.

October 2, 1922. All of the nodules have disappeared. The glands in the right axilla are much smaller.

December 6, 1922. There is a mass in the right breast with a line of nodules from it to the right axilla (Fig. 11).

December 9, 1922. The right breast was removed and radium inserted for 24 hours: 50 milligrams in inner wall of right axilla; 25 milligrams in posterior wall of right axilla; 25 milligrams near the apex of the right axilla.

January 28, 1923. The right side is all well; there are a few new nodules along the left costal margin. Further X-ray treatment was given.

May 1, 1923. The ulnar side of the right forearm was atrophied. Three new subcutaneous nodules were found over the eighth rib in the left midaxillary line. There were no visceral deposits.

July 22, 1923. Multiple small nodules were found to be present over the lower six ribs on both sides (Fig. 12).

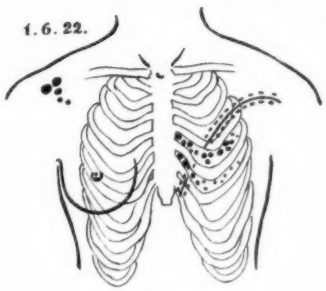

Fig. 10.

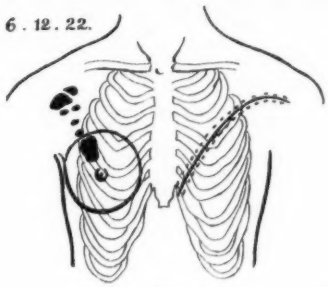

Fig. 11.

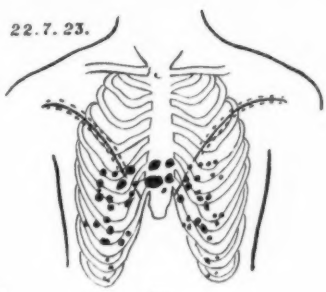

Fig. 12.

Oct. 10, 1923. The nodules are still active in the right axilla and over the right lower ribs in front and in the epigastrium. Dullness is present at the base of the left lung (Fig. 13).

May 3, 1924. Patient died, 12 years after primary operation. Up to within a fortnight of her death the patient remained active and able to conduct her business.

Let me now give you a brief account of a Group 3 case, which may be regarded as typical. This patient was operated upon for cancer of the left breast in 1920, and no doubt even then had extension of the disease in the thorax beyond the internal mammary glands, for only a year later she had a sternal deposit in the lower part of the gladiolus, which was successfully treated by radium. In 1924, a lump developed in the manubrium but this also disappeared under radium treatment. In April, 1925, no external manifestation of disease remained. She died with thoracic symptoms and signs of pressure on the left recurrent laryngeal nerve in March, 1926. At the necropsy the only malignant tissue found in the body was a mass of recurrent growth in the superior mediastinum.

In this case prophylactic radium might have prevented the sternal recurrences, but it would not have averted the mediastinal deposit, nor would it have prolonged life. The patient came too late, and had already passed irrevocably from Group 2 to Group 3.

Mary A., aged 75 in 1924. In July, 1920, the left breast was removed at the Hampstead General Hospital. In July, 1921, there was found recurrence on the left side of the sternum in the fourth interspace; tenderness in the supraclavicular triangle; no metastases elsewhere. Eight 10 milligram tubes of radium bromide were inserted into the sternal recurrence for 28 hours.

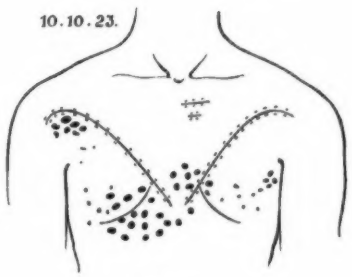

Fig. 13.

In August, 1922, recurrences were found at site of irradiation and at and below the old tumor site in the fourth interspace. Ninety milligrams of radium was placed in the center for 12 hours and nine 10 milligram tubes were arranged radially at the periphery for 24 hours.

In October, 1922, the glands were apparently removed from the supraclavicular region on the left side, but no notes can be traced of this operation or of the result of a microscopical section.

In July, 1924, we found a recurrence above the old irradiation site in the middle line, firm, adherent, and almost central over the sternum. No palpable glands or metastases were to be found. Five tubes of radium totaling 16 milligrams were buried radially with part of the tubes within the periphery of the tumor, 90 milligrams in the center of the tumor for 19 hours.

In August, 1924, there was found complete disappearance of the recurrence.

In April, 1925, examination showed no evidence of growth to be found locally or in any of the lymphatic areas draining the operation sites. The operation scar is normal and supple. The upper and lower sternal recurrence sites which had been treated by buried radium consist of flat, soft, supple, white scars with no evidence of subadjacent growth. The general condition of the patient is good

In May, 1925, the patient complained of attacks of hoarseness and loss of voice. Otherwise she is very well. There is no loss of weight and nothing abnor-

mal can be found in the thorax. She has been seen by Mr. Cleminson who reported that the left vocal cord was paralyzed in the cadaveric position.

In February, 1926, the patient reported that she has been quite well until recently when she has been troubled with swelling of the arm and left side of the face and she has begun to lose weight rapidly. The voice is still hoarse. There are dilated veins running from the right arm over the right side of the thorax and also from the thorax down to the abdomen as if there was some obstruction to the inferior vena cava. There is no external sign of recurrence but the patient looks ill and the whole picture is highly suggestive of an intrathoracic recurrence. An X-ray has been taken, but it is useless as the patient could not be made to keep still and hold her breath. She has been recommended for a permanent bed.

March 9, 1925. Patient has been admitted to Stafford Ward.

March 14, 1926. Patient died.

Postmortem findings. A large mass of firm recurrent growth was found in the superior mediastinum. It was adherent to the deep surface of the sternum and the upper left costal cartilages, to the clavicle, to the pleura, and to the vertebral column. It almost surrounded the arch of the aorta and the left subclavian and common carotid arteries; the left recurrent laryngeal nerve was embedded in it. The mass extended from just above the level of the clavicle to the third rib and from the posterior surface of the sternum to the vertebral column. From the third rib, close to the left side of the sternum, a small projection of the mass extended down as far as the upper border of the fifth rib. One small nodule was felt in the third intercostal space in the midclavicular line but no other secondary deposits were found. There was extensive bronchopneumonia of both lungs and the patient had two large gall stones.

Examination of the sites of radium treatment. 1. In 1921 and 1922, radium was inserted in the fourth space close to the left border of the sternum. At autopsy no growth was found in the skin and subcutaneous tissues but growth was found infiltrating the intercostal space directly below. This growth was in direct connection with the large recurrence in the superior mediastinum.

2. In July, 1924, radium was inserted in the middle line over the upper part of the sternum. At autopsy the skin, subcutaneous tissue, superficial surface and marrow of the sternum all appeared healthy and free from growth but the under surface of the sternum was closely adherent to the mass in the thorax. There was no necrosis of the sternum.

A painstaking microscopic examination of a vertical section taken through the subcutaneous tissue and the thickness of the sternum, showed the sternum to be quite normal. No growth was seen anywhere in the section.

3. Microscopic examination of the recurrence in the thorax. The section shows masses of spheroidal cells embedded in a well marked and very dense fibrous stroma—undoubtedly scirrhus carcinoma of the breast.

From the point of view of the treatment of local recurrences by radium, this is a most interesting case. Briefly, the history is as follows:

The original operation was performed in July, 1920; one year later, a recurrence in the fourth intercostal space was treated with radium and completely disappeared. Later it reappeared but radium again caused it to disappear—this time never to return. After another year, August, 1922, supraclavicular glands appeared and these were removed by operation. Four years after the original operation, July, 1924, a sternal recurrence was treated with radium, again with complete success. In May, 1925, signs of an intrathoracic recurrence became manifest and the patient died in March, 1926. At the postmortem examination, a large growth was found in the superior mediastinum.

The patient lived for nearly 5 years after radium treatment for the first recurrence and during the first four of those years, she was able to lead a perfectly normal existence, except for three short periods spent in hospital for the treatment of further recurrences. Without radium treatment, the patient would have certainly experienced all the troubles and discomforts which attend the presence of a large fungating mass on the chest wall. No doubt the seeds of the superior mediastinal growth which ultimately killed the patient were already present in the aortic glands when she first came under treatment.

PROPHYLACTIC RADIUM IN PRIVATE CASES

It is clear that to obtain the full advantage of prophylactic radium all the cases operated upon must come into Groups 1 and 2. That is not possible, but in private cases as contrasted with hospital cases it is probable that the cases come rather earlier and that Groups 1 and 2 will be larger in proportion to Group 3.

Fifty-six of my private patients who had prophylactic radium at the time of the radical operation for breast cancer have passed the 3 year limit and 46 of these have been followed up. Twenty-six of the cases traced remained free from recurrence 3 years after operation, a percentage of 56.5. Before I began to use radium, my percentage of 3 year

successes was 47. Though I do not wish to stress the figures, there is here evidence of the value of the method. A critic might object that the difference is too small to be significant and that perhaps it is due to cases coming for operation rather earlier than in former years. In this respect, however, there has been no marked improvement as Table I shows.

TABLE I.—CONDITION OF AXILLARY GLANDS WHEN FIRST SEEN

Period	No. of cases in which the condition of the glands was noted	Percentage which had hard axillary glands
Before 1915	65	73.8
1915 to 1920	106	76.4
1920 to 1925	182	69.9

It is evident that, though rather earlier than the hospital cases, my private cases on the whole were not a favorable group and that they included many Group 3 cases in which no benefit could be obtained except to avert local recurrence.

Absence of local recurrence in the sites where the radium tubes were placed. More definite evidence of the value of the method is to be found in the fact that as a rule when recurrence took place it was atypical in position, and did not occur at the points where the radium tubes had been placed.

Nine cases of supraclavicular recurrence were noted, but in 5 of these though radium had been used in the intercostal spaces, no radium had been used above the first rib. Of the remaining 4 cases of supraclavicular recurrence, 1 patient seen 6 years after operation had a doubtful gland above the clavicle but is still well. A second patient, an advanced case clearly belonging to Group 3, died with supraclavicular and thoracic recurrence 7 months after operation. A third patient remained well for 3½ years, then a hard gland appeared about the middle of the anterior border of the sternomastoid. This gland was above the region protected by radium. The fourth patient remained well for 3¾ years, then developed a gland in the outer part of the omohyoid triangle, away from the protected region. In Cases 3 and 4 it may be presumed that at the time of operation microscopic infection of the supraclavicular triangle had already at the time of the first operation spread beyond the gland at the lower and inner angle of the triangle which is always the earliest to show enlargement.

The most interesting case of all was one in which radium tubes were placed in the first, second, and third spaces but no radium was used above the first rib. Three and a half years later the patient appeared with a hard nodule deep down in the space between the sternal and clavicular heads of the sternomastoid. This was exposed by operation and was found to be a nodule of growth occupying the interval between the junction of the subclavian and internal jugular veins and infiltrating the walls of both veins. It thus occupied precisely the situation of the terminal part of the right lymphatic duct, in a position which, if I had adhered to my routine, would have been occupied by a radium tube. It was transfixed accurately with a radium tube, being obviously irremovable. Twenty months later the patient remained well and free from signs of recurrence. She died ultimately of cerebral deposits 7 years after the first operation. The disease probably spread upward to the brain by permeation of the lymphatics of the deep cervical chain.

This case possesses the attributes of a laboratory experiment. The only departure from routine was the omission to insert a tube of radium above the first rib. The only recurrence was a single nodule in the exact situation which should have been occupied by the missing tube. The nodule disappeared when treated late in the day with radium. It may be inferred, with great probability, that if my usual routine had been adhered to, recurrence would never have taken place.

Perhaps the most striking fact remains. In the whole series of cases, recurrence in the intercostal spaces was noted only five times. In only a single case did the recurrence occupy a space which had been protected by a prophylactic radium tube. In the 4 other cases, the spaces protected by radium—the spaces that is to say in which recurrence usually takes place—remained free though lower spaces were attacked. Presumably in these cases microscopic invasion of the lymphatic tract

had already, when the tubes were used, spread beyond the range of their influence.

The solitary case in which recurrence took place in a space protected by radium only 3 months after operation is an apparent rather than a real exception to the rule. The recurrence was close to the anterior axillary fold, not at the inner end of the space. No doubt at the time of operation permeation had already spread some distance backward along the lymphatics comitant to the intercostal artery, and beyond the range of the radium tube at the inner end of the space.

In conclusion I would not claim to have produced a scientific demonstration of the value of the prophylactic use of radium in breast operations, but only to have given such substantial evidence of its value as to establish its claims to serious attention. In the absence of evidence that any risk attends the procedure it is my definite opinion that the precaution should not in future be omitted.

As we get our cases earlier prophylactic radium will become more and more valuable. I am convinced that its use definitely extends the possibility of cure to cases in which it was formerly excluded, cases namely in which the earliest stage of invasion of the chest is already present when they are first seen.

In order to find the reason for the increased gravity of prognosis associated with enlargement of the axillary glands we must turn to the parasternal glands of the internal mammary chain. If the axillary glands are infected then probably so are the parasternal glands. The clearance of the axilla is easy and locally effective, but our results have been marred by a failure to recognize and deal with the more subtle and clinically unrecognizable process of parasternal invasion.

ADENOFIBROMA AND FIBRO-ADENOMA OF THE FEMALE BREAST

By JOSEPH McFARLAND, M.D., Philadelphia

TWO of the chapters in the book entitled *The Breast: Its Anomalies, Its Diseases, and Their Treatment*, by John B. Deaver and Joseph McFarland, undoubtedly left much to be desired from many points of view, and prompted the junior author to investigations that might throw additional light upon the subjects with which they dealt.

The first topic had to do with the cystic diseases of the breast, and led to a research in which an attempt was made to approach the subject through a study of supposedly normal breasts, with the idea of connecting previous physiological activities with later morphological alterations. In the results, which were published,[1] it was pointed out that certain histological appearances, not previously understood, and much feared as the probable beginnings of cancer, were but harmless survivals of antecedent secretory activities, and probably in no manner related to malignant disease.

The second topic, which forms the burden of the present contribution, deals with the more common of the fibro-epithelial tumors, and the differences, if any, that obtain between tumors known as adenofibromata and fibro-adenomata.

The primary difficulty that led to the unsatisfactory character of the chapter in the monograph referred to, lay in the confused state of the terminology used in describing these tumors, and inability to successfully harmonize the terminology in the limited time the author had at his disposal when preparing the book for publication. Things undoubtedly the same were called by different names, and different things by the same name. In some cases the denominations were correct, in some only partly correct, in some without any justification. But what was worst of all, numerous cases, classed as tumors, and called by many different names, all signifying tumors, were found not to be tumors at all.

[1] McFarland, J. Residual lactation acini in the female breast; their relation to chronic cystic mastitis and malignant disease. Arch. Surg., 1922, v, 1-64.

It seemed to be pretty generally understood that two principal types of non-malignant fibro-epithelial tumors occurred in the human breast, both "adenomata," but one appearing in youth as a well circumscribed firm nodular growth, histologically made up of an abundant soft fibrillar tissue through which duct-like structures, frequently deformed by intracanalicular growths, ramified; while the other, most common in the breasts of mature women, and less well circumscribed, was soft because composed chiefly of glandular tissue.

For the first of these the most popular name seemed to be adenofibroma; for the second, fibro-adenoma. But in not a few cases the terms were used interchangeably, so that it was necessary to begin by finding out whether the general understanding above mentioned was justified, or whether, in reality the two tumors were the same.

In order to secure enough material from which to draw reasonably accurate conclusions, friends, pathologists to 5 large hospitals, were asked to assemble from their surgical and laboratory collections, all the tissues designated by these names, or others suggesting relationship with them. The result was about 300 tissues that had been indexed under 33 different names!

Although seeming to be elaborate, the nomenclature was reasonably consistent in itself, and based upon sound scientific principles, that may be expressed as follows:

1. A benign tumor in which glandular units, with epithelium regularly disposed upon a basement membrane, are distributed throughout a supporting stroma of connective tissue, is an adenoma.

2. As the parenchymatous elements in many such tumors are less conspicuous than the fibrillar tissue stroma, leaving one in doubt whether the tumor be more properly regarded as of fibrillar tissue or of glandular tissue, it seems wise to give such tumors a special designation such as adenofibroma.

3. In case the parenchyma preponderates

over the stroma, a reversal of the form is used, fibro-adenoma.

4. As in mammary tumors the fibrillar tissue seems to be derived from the periductal tissue, Warren has called such tumors periductal fibromata.

5. As the fibrillar tissue is not infrequently very soft and like mucous tissue, it seems legitimate to further characterize such tumors as periductal myxomata.

6. When the stromal tissue is excessively cellular, altogether or in parts, some prefer to give such tumors the name periductal sarcomata.

7. As the arrangement of the periductal tissue, with reference to the parenchyma is peculiar, sometimes surrounding the ductules in a kind of concentric manner, sometimes growing into it in the form of rounded polypoid masses, names suggesting these relationships are used: Pericanalicular periductal fibroma or pericanalicular adenofibroma; intracanalicular periductal fibroma or intracanalicular adenofibroma.

8. Adding these to the already given names by which the other peculiarities of the tumors are known, we find: pericanalicular periductal myxoma or pericanalicular myxo-adenofibroma; pericanalicular periductal sarcoma or pericanalicular adenosarcoma; intracanalicular periductal myxoma or intracanalicular -adenomyxoma; intracanalicular periductal sarcoma or intracanalicular adenosarcoma.

9. To describe the more rare cases in which the parenchymatous element seems to preponderate, the names simple adenoma, pure adenoma, racemose adenoma, acinous adenoma, have been employed.

10. Should any of the parenchymatous elements become cystically dilated, some have thought wise to name the tumor: cystic adenofibroma, adenomyxoma, adenosarcoma, etc.

11. Any kind of a papillary excrescence, projecting into one of the ducts has suggested the employment of such terms as: papillary cystadenoma, intracystic papillary adenofibroma, papilliferous cystic adenofibroma.

Chief interest centered about those tumors that had been called fibro-adenomata, and it was uncertainty as to the significance of that term that threw confusion into the whole subject of the fibro-epithelial tumors, by appearing now in one, now in another category.

TABLE I.—NOMENCLATURE

Name under which the tissue was indexed	Tumors	Indeterminates	Non-tumors	Totals
Adenoma	1	1	0	2
Adenofibroma	8	2	48	58
Adenofibromyxoma	3	0	0	3
Adenomyxofibroma	8	1	2	11
Adenomyxosarcoma	0	0	1	1
Cystic adenofibroma	0	0	3	3
Cystic adenomyxofibroma	0	0	1	1
Cystic adenomyxoma	1	0	0	1
Cystic fibro-adenoma	0	1	0	1
Cystic fibroma	0	0	1	1
Fibro-adenoma	6	3	18	27
Fibro-adenomyxoma	1	0	1	2
Intracanalicular adenomyxofibroma	8	2	1	11
Intracanalicular fibromyxo-adenoma	0	0	1	1
Intracanalicular adenofibroma	6	0	2	8
Intracanalicular fibroma	2	0	0	2
Intracanalicular myxofibro-adenoma	1	0	0	1
Intracanalicular myxofibroma	2	0	0	2
Intracanalicular periductal fibroma	3	0	0	3
Intracystic papillary fibro-adenoma	0	0	1	1
Myxadenofibroma	1	0	0	1
Papillary cystadenoma	0	1	0	1
Papilliferous cystadenoma	0	0	1	1
Pericanalicular adenofibroma	0	0	1	1
Pericanalicular adenomyxofibroma	4	1	1	6
Pericanalicular cystadenofibroma	0	0	2	2
Periductal adenofibroma	2	0	0	2
Periductal adenomyxofibroma	2	0	0	2
Periductal fibroma	7	2	16	25
Periductal fibro-adenoma	1	0	1	2
Periductal myxofibrocystadenoma	0	1	0	1
Periductal myxoma	3	1	0	4
Periductal sarcoma	1	1	0	2
	71	17	102	190

The entire nomenclature used in the two largest hospitals is shown in the following tabulation of 190 tissues there found.

The collected material represented the work of a succession of competent pathologists assisted by many resident physicians on the pathological service. The extensive and diversified terminology was no doubt the result of sincere efforts on the part of all to be as accurate as possible, but it was bewildering and unnecessary. What were these things, the same, or different? If the same, why use so many names; if different, how do they differ?

One clear cut tumor there seemed to be, and the name by which it could be called without any ambiguity was *periductal fibroma*. It was decided to begin by examining all of the material with the microscope, laying aside all of the periductal fibromata and modifications

of them, and then analyze and study the remainder.

The custom in vogue in many hospital laboratories of marking the sections with a number only, facilitated this phase of the work by permitting each section to be studied without prejudice based upon what some former examiner had called the tissue. Known only by number, each slide was studied, and the diagnosis and peculiarities carefully noted for future reference, when the second part of the investigation, that dealing with the case histories, was to be pursued.

Not many cases had been examined before one was encountered in which there was no vestige of a tumor: only normal breast tissue was found. It was supposed to be an accident resulting from the wrong tissue having been sent to the laboratory, or the wrong piece worked up by the technician, though the fact that it had been described as a tumor was disconcerting. It was thrown out, but later, when the same circumstance had been repeated a number of times, it seemed necessary to take notice of it, so it was decided to make two chief classes of material, called respectively, *tumors* and *non-tumors*.

Curiously as the studies were continued, the non-tumor class outgrew the tumor class. There also appeared a number of cases the true nature of which it was impossible to decide. At one examination they were thought not to be tumors, at another, to be such: upon later re-examination they were returned to the tumor group, later to be removed from it again. These perplexing tissues were finally grouped together as a third group to which the name *indeterminates* was given.

At the close of the first part of the investigation the grouping of tissues stood tumors, 105; non-tumors, 147; indeterminates, 37, making a total of 289 different tissues studied and found useful for further analysis, the others having been thrown out because of some such reason as faulty technique or inadequate material.

The next step consisted in attempts to correlate the histological findings with the case histories, and resulted in many tiresome hours spent in the record rooms of the various hospitals. Unfortunately, the desired and sometimes the most important data were not forthcoming in a good many of the cases, and the data obtained varied for different cases. Thus, those upon which age data were obtained, were not either the same cases, or in the same number as those for which matrimonial data were available. Though it is always disappointing not to find in the case histories the facts most useful in the investigation under way, it cannot always be expected. It is only natural that a surgeon about to remove, under local anæsthetic, a small tumor of the breast, will disappoint some pathologist, who 10 years later may be most anxious to learn whether the operation was performed at the time the patient was menstruating, or in the interval between the periods, yet just such information is of the greatest importance when any mammary condition is under investigation.

It was necessary to utilize to the best advantage the data found, and what has been said is in explanation of the differing numbers of cases figuring in the various computations and tabulations that follow.

The data obtained are displayed in Tables II and III.

The case histories having been read and the useful data collected, the cases were assembled into groups corresponding with those resulting from the histological studies, that is, tumors, non-tumors, and indeterminates, after which the whole of each group, then each of its parts, was plotted and compared.

Figure 1, in which, as in all charts that follow, the ordinates represent numbers of cases, while the abscissæ represent years of age, shows the age distribution of all of the cases of all kinds—that is, tumors, non-tumors, and indeterminates, the average age being 32 years, and the mean, 33 years. The curve is almost identical on each side of the mean and average points, and regularly covers the entire period of the sexual life of the woman, beginning at about puberty, reaching its highest points in maturity, and rapidly declining after the menopause.

But as this chart is made up of all three of the groups into which the material was divided, it was, of course, necessary to analyze it into its several components, in order that they might be satisfactorily compared.

TABLE II.—FINDINGS IN ONE HUNDRED SIXTY-EIGHT CASES

I. Tumors				
1. Marital state not known				
a. Age not known	35			
b. Less than average of 32 years	3	39		
c. More than average of 32 years	1			
2. Unmarried				
a. Age not known	3			
b. Less than average of 32 years	31	38	105	
c. More than average of 32 years	4			
3. Married				
a. Age not known	3			
b. Less than average of 32 years	12	28		
c. More than average of 32 years	13			
II. Indeterminates				
1. Marital state not known				
a. Age not known	20			
b. Less than average of 32 years	0	21		
c. More than average of 32 years	1			
2. Unmarried				
a. Age not known	0			
b. Less than average of 32 years	2	7	37	289
c. More than average of 32 years	5			
3. Married				
a. Age not known	0			
b. Less than average of 32 years	2	9		
c. More than average of 32 years	7			
III. Non-tumors				
1. Marital state not known				
a. Age not known	47			
b. Less than average of 32 years	0	49		
c. More than average of 32 years	2			
2. Unmarried				
a. Age not known	2			
b. Less than average of 32 years	17	34	147	
c. More than average of 32 years	15			
3. Married				
a. Age not known	4			
b. Less than average of 32 years	10	64		
c. More than average of 32 years	50			

TABLE III.—CONSIDERATION BY AVERAGES OF AGE DATA OF DIFFERENT GROUPS

I. Tumor Cases
Average age of all
a. At time of first discovery.....26
b. At time of operation.....27.8
A. Unmarried women
a. Average age at time of first discovery.....20
b. Average age at time of operation.....23.8
B. Married women
a. Average age at time of first discovery.....32
b. Average age at time of operation.....33.28

II. Indeterminate Cases
Average age of all..31.7
Unmarried women 30
Married women..37
A. Unmarried women
a. Average age at time of first discovery.....31
b. Average age at time of operation.....33

III. Non-tumor Cases
Average age of all
a. At time of first discovery.....37.2
b. At time of operation.....38.5
B. Married women
a. Average age at time of first discovery.....38
b. Average age at time of operation.....38
c. Average age of parous women..35.3
d. Average age of non-parous women..37

Figure 2 shows the curve formed by the tumor cases. The average age of this group is 28 years, and the curve is almost entirely confined to the early half of sexual life. Beginning at about puberty, the curve rapidly rises, its highest point being reached at the nineteenth year, after which it gradually declines, until after the thirtieth year when only an occasional case occurs. This chart shows the age at which the patients were operated upon.

Figure 3 shows the tumor cases, of married and single women, at the ages at which it is stated that the tumors were first discovered. It repeats the curve seen in Figure 2 and differs from it only in that the number of cases in which the age data were given was smaller (47 instead of 60 cases), and that this treatment of the data has the effect of diminishing the average age of the patients to 26 years.

The question next arose as to the effect of separating the unmarried and married groups and constructing a curve for each. With such increase of required data, the number of cases diminished rapidly, so that the sources of error multiplied, but it seemed possible to arrive at some useful information. Figure 4 shows the curve of tumor cases in single women. The general character of the curve is unchanged, but with the exception of 5 cases, the entire group becomes centered in the first half of the age distribution. However, the curve for the married women, Figure 5, is quite different. In reality there is no curve, but almost an

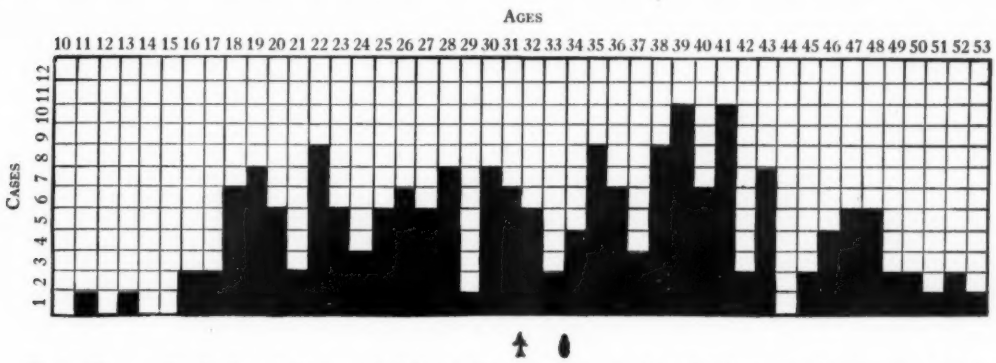

Fig. 1. The age distribution of all cases of all kinds. The average age is shown by the arrow, the mean point by the oval. There is a fairly regular ascent from the left and descent to the right, forming a regular curve covering the whole period of sexual female life from puberty to the menopause.

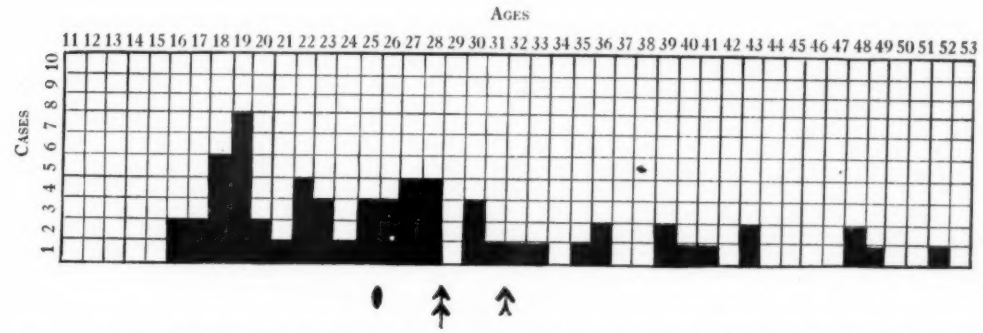

Fig. 2. The age distribution of the "tumor cases," of married and unmarried patients at the time of operation. The arrow shows the average age in all cases, 32 years; the double arrow, the average of this group, 29 years; the oval, the mean point. There is a characteristic curve rising suddenly between the sixteenth and nineteenth years, and then gradually declining. Three-fourths of the cases are to the left of the average age line for all cases.

equal number of cases at all ages from maturity to the menopause.

Taking next the non-tumor cases, the first plot, Figure 6, shows the curve for married and single women at the age of operation. In a general way, it is exactly the reverse of that of the tumor cases, for it begins at about puberty, rises gradually, and reaches its highest point about the fortieth year, after which it rather rapidly declines.

If those cases concerning which the age of first occurrence is known be separately plotted, Figure 7, the general character of the curve is unchanged, and the highest point, as well as the majority of the cases, are in the latter half of sexual life.

But when the cases of married and unmarried women are separated and charted independently, a difference similar to that found in the separation of the tumor cases, married and unmarried, makes its appearance.

Thus, Figure 8 shows the non-tumor cases in married women, at the age of first occurrence. It differs only in the slightly later average age of the patients. But Figure 9, which shows the plot of the unmarried women at the time of the first appearance of the non-tumor lesions, is entirely different in presenting a regular curve regularly extending over the whole of the sexual life from adolescence to the menopause, the average age of the patients, the average age of all, and the mean

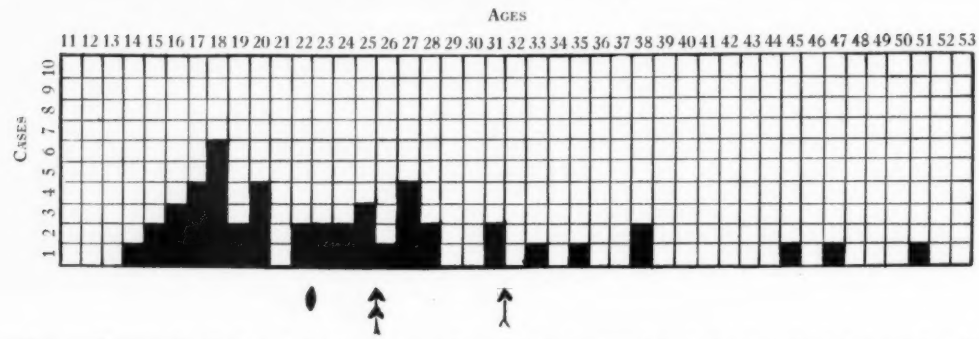

Fig. 3. The age distribution of the "tumor cases," married and unmarried, at the time the lesion was first discovered. The average age is 26 years. The single arrow shows the average age for all cases, the double arrow the average age for this group, the oval the mean point.

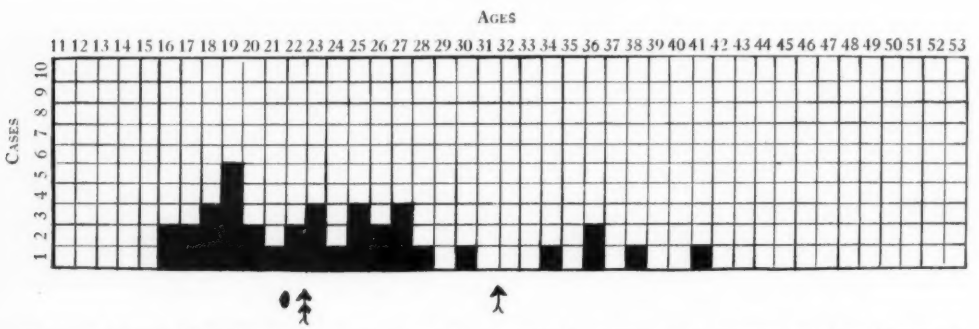

Fig. 4. The age distribution of the "tumor cases" in unmarried women. The average age for the group is 23 years. The curve rises and falls to the left of the average age for all, and differs from that shown in Figure 3 only in making the average age 3 years earlier. The arrow shows the average age for all cases, the double arrow the average for the group, the oval the mean point.

points all being very nearly in the same place.

Taking next the indeterminates, of which too few were accompanied by satisfactory age data, the general plot, Figure 10, showing all cases, of married and single women, can scarcely be said to form any curve at all. But remembering that they may really have belonged either to the tumor class, or to the non-tumor class, one has a right to inquire how the respective curves of those classes might be modified by combination with them.

Figures 11 and 12 were therefore prepared, Figure 11 to show all tumor cases plus all indeterminates, and Figure 12 all non-tumor cases plus all indeterminates. In order to have the greatest possible number of cases, the plotting was done with the use of the ages at which the patients were operated upon. It will be seen at a glance that the general tendency of the respective curves is in no way changed by the additions.

It is now quite evident that the cases called tumors have their greatest incidence some 10 years earlier than those of the group called non-tumors. Is there any way to account for this difference? Have the different histological conditions something to do with maternity? The great majority of the non-tumor patients were married, and most of them had had children, in all probability. Plottings were made of the tumor cases known to have had children, Figure 13, and of the non-tumor cases known to have had children, Figure 14.

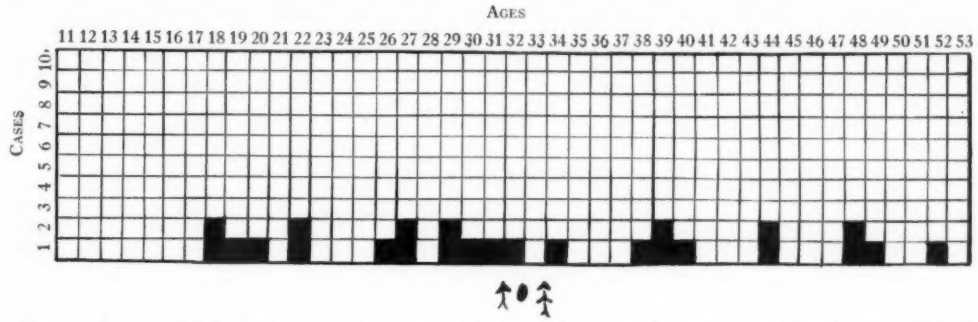

Fig. 5. The age distribution of the "tumor cases" in married women, the average age for the group being 34 years. In this case there is no curve.

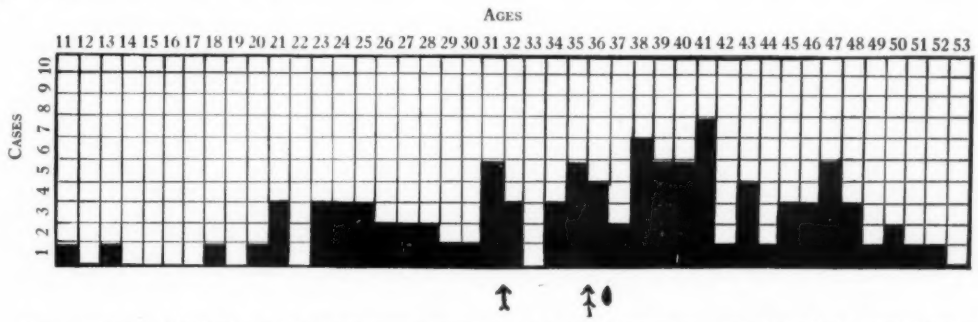

Fig. 6. The age distribution of the "non-tumor cases" at the time of operation. It includes both married and unmarried women, the average age for the group being 36 years. A curve is formed, that beginning at maturity, gradually ascends, finding the highest point about the forty-first year, then gradually subsiding. This curve is in the opposite direction to that formed by the "tumor cases," the highest point and greatest number of cases being to the right of the average age for all cases.

Although the number of cases is so small that errors may be great, it is interesting to see that no change occurs in the curves normal to the respective classes. The average age of the tumor cases is 28 years, and nearly all are in the youthful period, while that of the non-tumor cases is 35 years, and the greatest height of the curve is about the fortieth year, most of the cases being in the latter half of life.

From this it seems probable that it is age and not maternity that determines the distribution of the tumor and non-tumor cases.

When all things are considered, the analyses and plottings seem to show the following facts:

1. The "tumors" are lesions of the first half of sexual life (average age of the patients 28 years), appearing with adolescence, increasing rapidly until the period of full sexual activity, then gradually declining in numbers. The firmness of the juvenile breast, as contrasted with its later softness, makes it probable that the discovery of some of the more deeply situated tumors is not made until, after lactation or the menopause, the patient is easily able to feel them.

2. "Non-tumors" are lesions occurring chiefly in the second half of sexual life (average age of the patients 37 years), and in married women. It is true that 32 cases occurred in unmarried women, but their age curve seemed only to show that a few cases occur at all ages.

3. "Indeterminates" like the "non-tumors" in unmarried women, scatter themselves in about equal numbers over the whole period of sexual life.

4. As the "tumor" cases among married women that had had children were four times

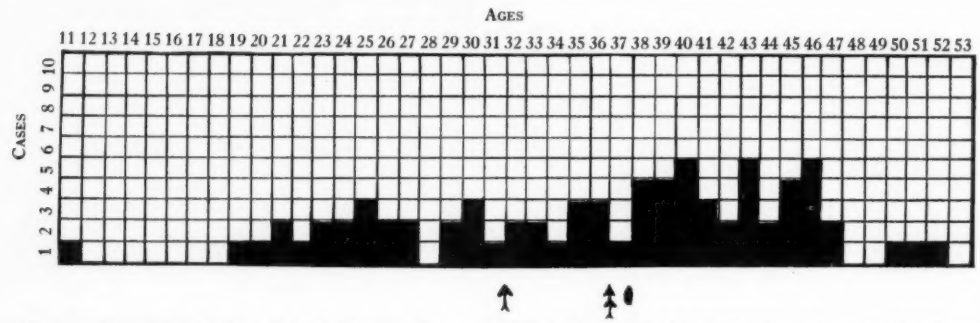

Fig. 7. The age distribution of the "non-tumor" cases, unmarried and married, at the time when the disturbances were first observed. The average age for the group is 37 years. There is no difference in the curve shown on the chart and that on the chart in Figure 6.

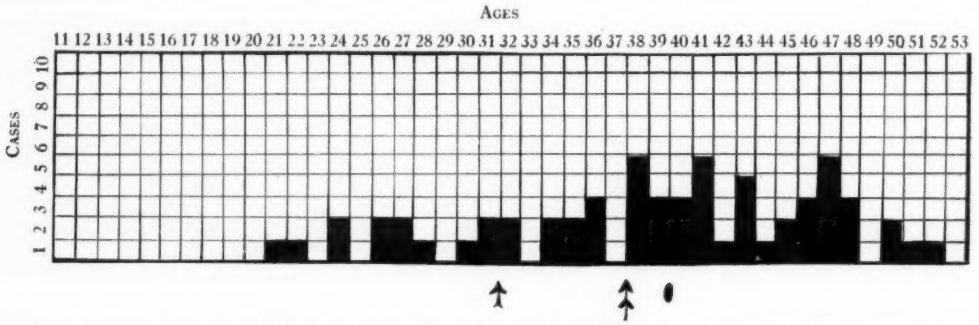

Fig. 8. The age distribution of the "non-tumor" cases, in married women, at the time at which the disturbances were first noted. The average age rises to 38 years, and only 1/5 of the cases are on the left of the average age for all cases.

more frequent prior to the average age for all cases, and the "non-tumor" cases twice as frequent after it, there seems to be reason to suppose that it is age and not maternity or matrimony that determines the difference between the lesions.

Of 41 "tumor" cases with the necessary data, the average pre-operative duration of the lesions was 4 years. Many were naturally of much longer duration—16, 12, 12, 12, 10, 10, 10, 7, 6, 5, and 5 years respectively. In a few cases the duration was said to have been very short—8, 6, and 3 weeks. As the patients would naturally suppose that their first observation of the respective tumors coincided with their first appearance, their statements in regard to them must not be given too much weight. However, as short duration plays an important rôle in the "non-tumor" cases, it must not be slighted here.

Of 69 "non-tumor" cases with similar data, the average duration was found to be 1 year, 9 months, and 1 week. The greatest variations in the pre-operative duration were found in this group. Many were known to have existed for long periods—18, 10, 10, 10, 8, 8, 8, 7, 6, 6, 5, 5, 5, and 4 years respectively. Others were said to have existed only for weeks, and a few for days only—10, 10, 5, and 3 days.

It now seems advisable to make a careful analysis of the acquired data regarding each of the major groups, beginning with those designated "tumors," which will hereafter be known by that name believed to be appropriate for all, periductal fibroma.

THE TUMOR GROUP, PERIDUCTAL FIBROMATA, ADENO-FIBROMATA, ETC.

Of the 105 cases whose histological structure placed them in this class, the average age was

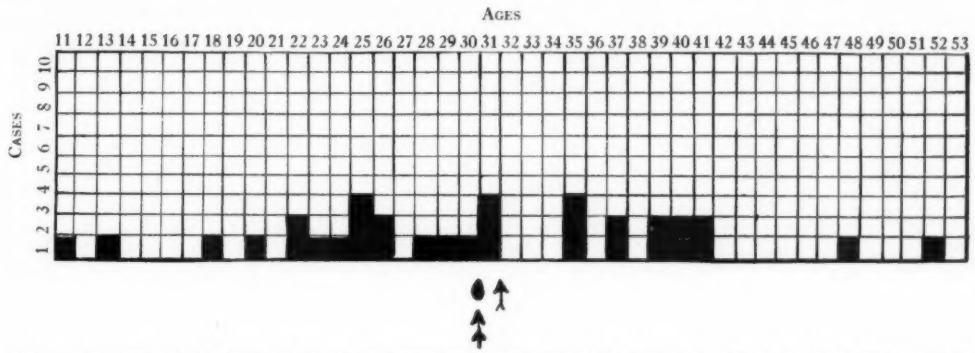

Fig. 9. The age distribution of the "non-tumor" cases in unmarried women, at the time the disturbances were first detected. There is a regular curve, the highest point being the average age for all cases; the average age for this group and the mean point coincide.

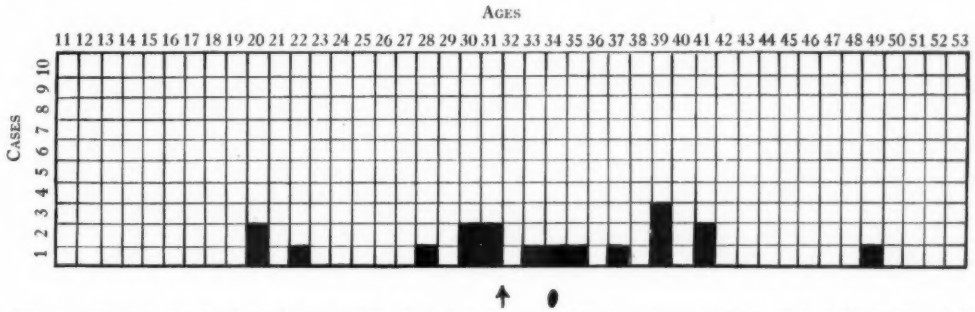

Fig. 10. The age distribution of the few "indeterminate" cases with the necessary data. It includes both married and unmarried women, and shows the age of operation. There seems to be a regular curve at the high point of which the average age for all cases, the average age for this group, and the mean point all cluster.

26 years at the time the lesion was first discovered. Only 26 per cent of the patients were married; only 10 had borne children. The average pre-operative duration of the lesions was 4 years, the extremes being 16 years and 3 weeks. In 4 cases the lesions were multiple in one breast, in 4 multiple in both breasts. In 19 cases they were in the right, in 22 in the left breast. In 2 cases the tumor was described as "sensitive"; in 12 cases it was expressly stated that there was "no pain." In 4 cases the tumor was said to "become larger during the menstrual periods."

In 27 cases the size of the tumor was compared to a walnut in 7, to a hen's egg in 7, to an olive in 3, to an almond in 2, to a marble in 1, to a cherry in 1, to a hazelnut in 1, to a lemon in 1, to an orange in 1, and to a grape fruit in 1.

In nearly all cases it was stated in the pathological description, that the tumor was "well encapsulated." But in the case reports the expressions employed by the surgeons in describing their operations, leave one in doubt as to exactly what they found. Thus, in 11 cases a tumor is said to have been "removed"; in 3, it was "shelled out"; in 3, it was "dissected out with scissors"; in 2, "enucleated"; in 9, "dissected out"; in 11, "excised"; in 1, "a small fibro-adenomatous growth was excised"; in 1, a "small hard mass, evidently a fibroma, was excised"; and in 1 case "the breast was amputated."

The tumors usually occurred as more or less bosselated nodes. Rarely they consisted of several, or even numerous, closely approximated nodes or coalescent nodules. Each node or nodule was composed of fairly uniform

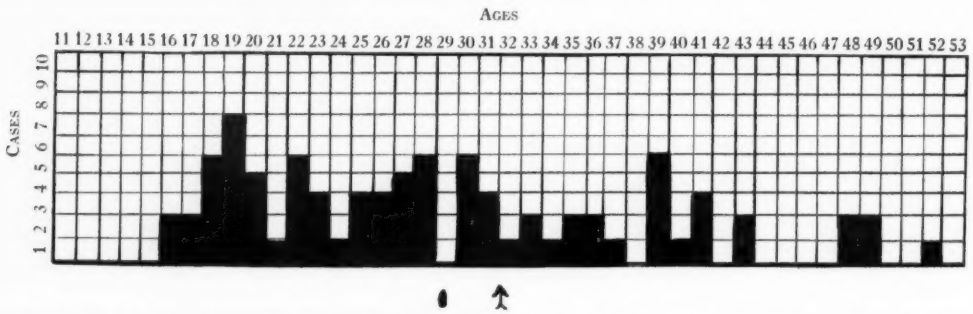

Fig. 11. The age distribution curve of all of the "tumor" cases plus all of the "indeterminate" cases, at the time of operation. When compared with Figure 2, the curve shows no change in general character.

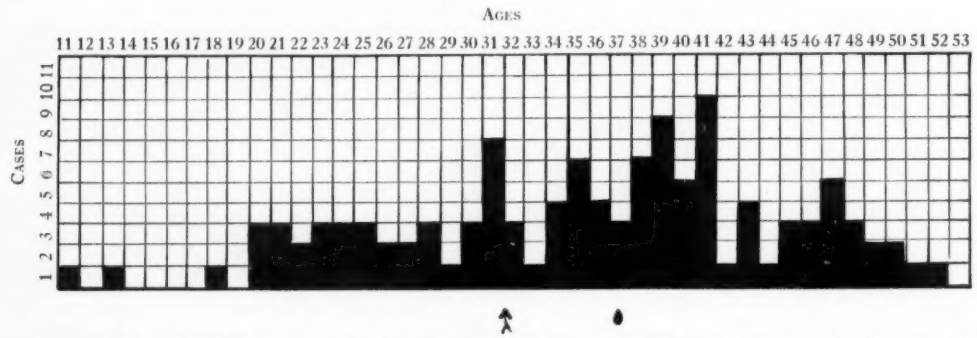

Fig. 12. The age distribution curve of all of the "non-tumor" cases, married and unmarried, plus all of the "indeterminate" cases at the age of operation. By comparison with Figure 6 it will be found that the general character of the curve is unaltered.

pinkish-gray fibrillar substance, the cut surface of which, being under tension, bulged convexly when the tumor was cut in half, and appeared finely fasciculated.

The presence of adipose deposits in the tumors was observed in two or three cases only, those being large tumors made up of several fairly distinct nodes, between which small groups of fat cells occurred. In no case were fat cells observed in the tumor nodules themselves. This may be explained through the homology between the stroma of the tumor and the periductal tissue of the breast into which fat cells were seen to penetrate only once in more than 200 cases studied.

Careful inspection of the cut surface usually reveals a number of short straight or curved slits or crevices, which are the duct-like structures composing the parenchyma. Their number and size differ in different tumors, and in some, they appear larger and rounder because distended with secretion. When very large, they may give the tumor a "cystic" character. They are more numerous and more obvious in those tumors that are said to have suddenly become larger or grown rapidly, and are most so in tumors that grew from a small to a large size in the course of days, in which there may be large numbers of large cystic spaces filled with fluids whose varying appearance run the gamut of mammary secretion, from watery fluid, thin milky fluid, milk, to thick rich yellow cream. The rapid enlargement of the tumor thus becomes explained through its secretory activities, and not through the growth of its tissues, although remarkable changes in them may also be found, as will be pointed out when the histology is considered.

Large tumors are apt to have many good sized cysts into which rounded polypoid or

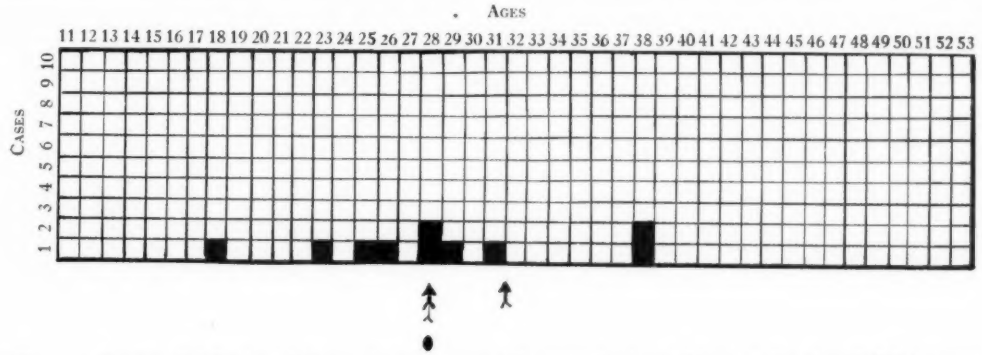

Fig. 13. The age distribution of "tumor" cases in married women having children, at the time the disturbances were first observed. All but two cases are to the left of the average age for all cases, the average age for the group being 28 years. Compare this chart carefully with Figure 14 and see how the one is the reverse of the other.

fungous excrescences project, and very large tumors may have cysts of great size with such excrescences as large as the terminal joints of the fingers.

Microscopic sections of these tumors never show a structure corresponding with that of the mammary gland, but with one of its lobules. It is made up of finer or coarser connective tissue, analogous with the periductal tissue, through which course single ductules or systems of ductules terminating in blind ends frequently dilated into cæcal pouches.

The connective tissue represents the periductal tissue of what seems to correspond to an exaggerated mammary lobule, the ductules correspond to those ordinarily found in a lobule. Such correspondence in structure gives the impression that the tumor may arise through enlargement of a lobule or a group of closely approximated lobules, each of which contributes a node to the general nodular structure of the tumor.

The proportion of ductules to stroma differs in different cases. Usually there seem to be about as many as commonly occur in a mammary lobule. But there may be fewer, and occasionally so few that the tumor may be mistaken for a fibroma; or there may be many more than normal. The comparatively rare cases in which acini make their appearance will be discussed later.

The epithelium lining the alveoli is usually regularly disposed in a single layer of cuboidal cells, though in some cases two layers—secretory and basket cells—may be met. The cells are not always of the cuboidal shape; they may be tall and columnar, or elongated. In a case studied at the Pennsylvania Hospital, through the kindness of Dr. John R. Paul, they appeared in the form of large spindles, and in such numbers as entirely to fill the alveoli, and perplex the observer. It is quite common for the cells to be unequal in distribution: in a single layer, for the most part, they sometimes fade away over the intracanalicular polypoid growths soon to be mentioned, or pile up in the deeper recesses between them. Such irregularities seem to be of no significance, and must not be thought of as indicative of "malignant" tendency. The number of periductal fibromata proving to be malignant falls to zero when clinical proof of the supposed histological indication of malignancy is demanded.

The fibrillar tissue of the stroma varies in different tumors, and in different parts of the same tumor. In some tumors, and in parts of tumors it is very fine and loose, resembling that of the nasal polypi; in other tumors or parts of tumors it is coarse and relatively dense. Attempts to correlate the density of the stroma with the age of the tumor were unsuccessful, possibly because not all parts of the tumors were of the same age.

The proportion of cells to fibers also varied. In some tumors, and some parts of tumors, there were very few cells, in others so many as to suggest the possibility of sarcomatous

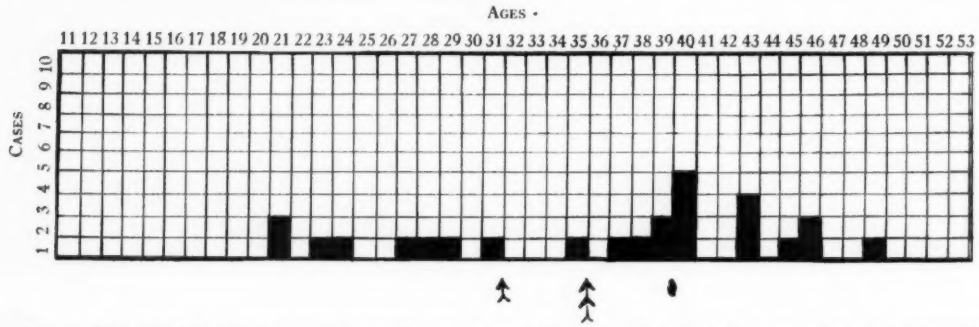

Fig. 14. The age distribution of "non-tumor" cases in married women having children at the time the disturbances were first detected. Two-thirds of the cases are to the right of the average age for all cases, the average age for the group being 36 years.

growth. In a few tumors the matrix consisted almost entirely of spindle cells—adenosarcoma. The fungoid ingrowths of the intracanalicular tumors were almost always composed of loose fine fibrillar tissue, and sometimes of œdematous, myxœdematous, or, indeed, mucous tissue.

The perilobular mammary tissue is thrust aside as the periductal tissue increases in quantity, to form the capsule by which the tumor is surrounded.

Among the 105 tumors there was one no larger than a pea, and one as large as a goose-egg, with all the intermediate sizes. As the smallest were, for the most part, intracanalicular tumors, it seemed natural to suppose that it was in that form that they usually arose, but as some of the large intercanalicular tumors showed the intracanalicular projections only in parts of their structure, it is not impossible that they may be also a late development in tumors of other varieties.

It will not now be *mal apropos* to consider briefly the specific varieties of the tumor:

1. *Intracanalicular periductal fibroma.* As there were 63, or 60 per cent, intracanalicular periductal fibromata in the series of 105, this variety evidently occurs more frequently than any other. It is characterized by local swellings of the stroma that take the form of ingrowths of polypoid shape that project into and stretch the alveoli, transforming them from rounded cylinders to flattened spaces, spread over the polypoid excrescences. The intracanalicular ingrowths vary in size according to the age and size of the tumors. When the tumors are small, they may be so minute as barely to be seen; when they are large, they may equal the end joint of the finger. The larger excrescences are not infrequently devoid of epithelial coverings, as though the stretching had drawn them apart. The recesses, on the other hand, are frequently filled with what seems to be an excess of cells.

2. *Intercanalicular periductal fibroma.* Twenty-one, or 20 per cent, of the series were intercanalicular periductal fibromata, a not generally recognized variety. The stroma consisted of a soft, loose periductal tissue, through which ductules and systems of ductules terminating in cæcal, slightly expanded endings, regularly and uniformly ramified. The stroma showed no definite relationship to the parenchyma; that is, it neither grew into it nor surrounded it concentrically.

In a few cases the ductules terminated in complicated branched endings, some such tumors having been removed from patients known to have been pregnant.

Tumors removed from patients known to have been lactating, either contained aggregations of acini or were so largely composed of them as to give the impression of an entirely different genus of tumor. Such an appearance probably explains why similar tumors have been described as "simple adenoma," "racemose adenoma," "alveolar adenoma," etc.

3. *Pericanalicular periductal fibroma.* No tumor regularly presenting a concentric

arrangement of the periductal tissue about its tubules was found among the 105 tumors examined, but in two cases such arrangement was found in parts of tumors otherwise frankly of the intracanalicular type.

This seems to prove the rarity of the pericanalicular variety among the tumors of the female breast. But in another series, made up of tumors from male breasts, the periductal arrangement of the stroma was frequent. It seems, therefore, to belong to tumors of the male rather than of the female breast.

As the fibrillar, myxomatous or cellular type of the stroma of these tumors has been made an excuse for further dividing them into fibromata, myxomata, and sarcomata respectively, it seems worth while to examine these conditions more particularly.

a. Periductal fibroma. In the periductal fibromata the stroma was fibrillar without mucoid, and without excessive numbers of fibroblasts. The fibers were sometimes very fine, sometimes very coarse. A few tumors with dense coarse fibers throughout had a known pre-operative duration averaging 13 years; a few with very fine fibers averaged only 4 months. It seemed as though duration had something to do with the quality of the stroma, and it was surmised that when parts of the same tumor showed both types of tissue, the coarser was the older. But one tumor composed entirely of finely fibrillar and myxoid stroma, is known to have existed for 18 years, one with finely fibrillar stroma highly fibroblastic in spots, had existed for 5 years; one coarsely fibrillar, but fibroblastic in spots, was only 18 months old, while another coarsely fibrillar in some parts and finely fibrillar in others, had existed for 6 years. Other factors than age therefore probably play a part in the modification of the histological structure of these tumors, so that one may not predict from the age what its histological structure will be, nor by a histological examination of the tumor tell its age.

b. Periductal myxoma. Many of the tumors described under the name of periductal myxoma proved upon more careful examination to be œdematous and not myxomatous. The œdema did not, as a rule, affect the entire tumor. It chiefly occurred in the intracanalicular variety, presenting itself for the most part in the intracanalicular polypoid excrescences.

It was not always simple œdema, but was frequently attended with the presence of a certain amount of mucus, so that it seems justifiable to call it myxœdema. As a certain quantity of mucus was found in the interstices of the stroma of the healthy breast in 75 per cent of those organs examined, it is in no way remarkable that it should be found in tumors of the organ.

But in a few of the tumors, true mucous tissue was present—that is, tissue characterized by the presence of the "star-like reticulum." It did not occur in any tumor with a pre-operative duration of less than 1 year, and the average age of those showing it was 3 years.

c. Periductal sarcoma. This variety is characterized by a stroma so cellular or fibroblastic as sometimes to seem to be composed of cells only. In many cases the short spindle cells are not to be differentiated from those of sarcoma, hence the name periductal sarcoma. But not all of the tumors are equally cellular throughout; many are highly cellular in certain areas only, the remainder being of the usual fibrillar appearance.

It seems to be pretty well understood that such supposedly periductal fibromata as later show themselves to be malignant, do so through sarcomatous behavior and not through carcinomatous change. What then may be the relation of excessively cellular stroma to sarcoma? If parts of the tumor are excessively cellular may it not indicate only that those parts were growing more rapidly than the remainder? Does excessively cellular structure throughout indicate simply that the whole tumor was growing rapidly?

Tumors supposed to be periductal fibromata have been known to grow very slowly for years, then to begin a much more rapid growth, and to show upon microscopic examination an excessively cellular stroma thought to be indicative of sarcoma—indigenous sarcoma of the breast. Were they really originally periductal *fibromata*, or were they *sarcomata* from the beginning? The stroma of one small tumor of the present series was entirely made up of small spindle cells, and

was called sarcoma, although it contained the usual parenchyma distributed according to the plan here called intercanalicular. Unfortunately the postoperative history of the case could not be traced. All that is known is that the patient never returned to the hospital for additional treatment or advice.

As a matter of fact, not one of the patients, with excessively cellular tumors, cellular throughout or only in parts, is known to have returned because of tumor recurrence or other manifestations of malignancy.

One interesting case was successfully followed: It was a tumor in the breast of a girl 17 years old, where it had been for years, growing very slowly until shortly before removal, when it had begun to grow rapidly. It had a very cellular stroma, and was reported upon by the pathologist as a spindle cell sarcoma, or, to use his own words, as an "adenofibroma that had undergone sarcomatous degeneration." The patient is living and well, four years after its removal, there having been no recurrence of the tumor.

It seems scarcely justifiable to regard periductal fibroma, periductal myxoma, and periductal sarcoma as other than variations of the same thing.

Most writers make mention of the intracanalicular and pericanalicular, but scarcely any of the *intercanalicular* periductal fibromata. It was in his *Textbook of Pathology* published in 1904 that the writer first pointed out the existence of the last mentioned type, and showed its structure by means of a diagram. Further attention was directed to it in his *Surgical Pathology*, and the same diagrams published, in 1924. Its importance will perhaps best be evidenced by the following histological tabulation of the 105 tumors:

	Cases
Intracanalicular periductal fibromata (60 per cent)	63
Intercanalicular periductal fibromata (20 per cent)	21
Combined intra- and intercanalicular periductal fibromata	1
Pericanalicular periductal fibromata	0
Intra- and pericanalicular periductal fibromata	2
Nondescript, i.e., not, for some reason, classifiable	8
Tumors modified by acknowledged or suspected pregnancy	6
Tumors modified by lactation	4
	105

It was usually easy to recognize the lactating tumors, both by the hypertrophy of their parenchyma, and by the presence of secretion in their ducts and acini. In one tumor, removed just before lactation began, on account of rapid increase in size and the fear that it was malignant, the whole tissue was glandular and acinar; in another removed after lactation had begun, the ducts were greatly distended with a thick yellow cream.

Arguing from such cases it seemed as though the tumor tissue ought to show changes characteristic of pregnancy. If the lactating tumors just mentioned showed lactation hypertrophy at its height, tumors removed during pregnancy ought to show the beginning and progress of the mammary hypertrophy according to the duration of pregnancy. It may do so, but the number of cases with accurate data upon the existence of pregnancy were too small to enable a conclusion to be reached, and there were a few contradictory evidences.

Remembering that enlargement and sensitiveness of the mammary glands is one of the first signs of pregnancy, we thought it possible that sensitiveness of the tumors might throw some light upon the problem, but a review of the case histories showed practically uniform absence of tenderness. It was also thought that the age of the tumor might be indicative of the physiological state of the patient, but no connection between the two could be made out.

So it became necessary to be content with the observation that although certain histological appearances quite regularly accompanied pregnancy, they in themselves were no satisfactory evidence for or against its existence.

Mammary glands respond to a variety of growth stimuli. One occurs a few days after birth, and manifests itself in the infantile secretion known as "witch's milk"; another shows itself at puberty, and causes the breast to grow to its adult proportions, though sometimes it does not stop there, but continues until a massive size, even as great as a weight of 60 pounds, is reached.

The next stimuli result from pregnancy, when great parenchymatous activity shows itself in the preparation of lactation, and

here, again, instead of developing to the appropriate size for the performance of the function that is about to be exercised, the breast may grow to massive as well as useless proportions. But in addition to these well recognized stimuli, some cases seem to respond to unusual influences, as when the breast secretes at each catamenial period, or when milk appears in the virgin breast as the result of letting an infant suck at the nipples, or because of digital manipulation of the breast. Local glandular hypertrophy may also occur because of the presence of tumors or other pathological lesions in the neighborhood of the tissue so disturbed.

The tissue of the periductal fibromata seems to be susceptible to the same stimuli.

It may be because of the growth stimulus at puberty that so many of the tumors are referred to about that time, as the period of their first discovery. It may be because of frequent manipulation that some of them grow more rapidly than others. Pregnancy is accompanied by a great impetus to growth, and many tumors have been removed during its course because, though long known to have been present, they suddenly began to grow. Several of the most interesting tumors in the present series were removed at the beginning of lactation because they grew to many times their original size in a day or two, evidently because they had begun to lactate, with no way of getting rid of the secretion that was distending their ducts.

Several authors, among them Ribbert, are quite emphatic in stating that periductal fibromata do not secrete when lactation is in progress. They frequently do not; but they may do so and excessively. All tumors do not equally receive the growth and secretory stimuli. Patients may pass through pregnancy and lactation with no change in small tumors in their breasts. Even when there are several tumors in the same breast, they may react differently, as is shown by the following case history:

Mrs. F. W., aged 28 years, white, married, had one young child, and miscarried in July. In August of the same year she consulted her physician because a small tumor that had been present in her breast for a number of years had become larger and tender. Later a surgeon was consulted, and she was advised that she might have a malignant tumor, and that the breast had better be removed. She accordingly went to a prominent hospital, and on October 28 of the same year, 3 months after the miscarriage, the breast was amputated. She made an uneventful recovery, and 6 years later died of peritonitis following appendicitis, having refused operation. There had been no return of the tumor, nor had she had any further trouble with the breast.

When the breast was examined in the laboratory of the hospital, it was found to contain 3 separate tumors, 1 about 3, 1 about 1½, and 1 about 1 centimeter in diameter. The smallest appeared to be much the same, but the largest was quite different in gross appearance. Upon microscopic examination the following histological structure was found:

1. The smallest tumor was a combination of intracanalicular and intercanalicular periductal fibroma. In the intracanalicular portions a few of the rounded polypoid eminences were distinct and typical, in other parts the parenchyma was hypertrophied to a considerable extent.

2. The next larger tumor contained no intracanalicular eminences at all, but consisted of a scanty stroma, in which the parenchyma varied. One half contained numerous ducts distended with what resembled colostrum corpuscles, the other contained so many and such closely packed ductules as to recall the "simple adenomata." Some of them were misshapen and crowded and had the epithelial cells so irregularly distributed that the pathologist suspected epithelial invasion, and feared "malignant disease."

3. The largest tumor was alveolar or racemose, its parenchyma so hypertrophied as to consist chiefly of acini, and so actively secreting that, there being no outlets for the escape of the fluid, it was distending the ducts into cystic spaces, one very large cyst being filled with yellow creamy contents.

The different appearances presented by these tumors are interpreted as depending upon the differing degrees in which their tissues had responded to the growth stimuli, and participated in the lactation hypertrophy of the breast during the pregnancy that had terminated in the miscarriage 3 months previously.

THE NON-TUMOR GROUP—FIBRO-ADENOMATA

Among the 289 cases studied there were 147 of the lesions declared not to be tumors. Of 94 patients the ages of whom were known, the average age was 37.7 years, or nearly 10 years greater than the average age of the tumor cases.

The histological examination of the tissues removed from the breasts of these women showed nothing corresponding with the histology of any recognized tumor, but always tissue in full correspondence with the structure of the breast itself. Not only was that true, but the appearances in each case were in full correspondence with the age and physiological requirements for the individual concerned, so far as data upon such matters were available. That is to say, the tissues removed from young patients showed the fibrillar matrix and rudimentary lobules of youth; those from multiparæ past middle life, the evidences of involution and abnormal involution seen ordinarily in the breasts of women of that age and condition; those from pregnant and parturient women, the lactation hypertrophy expected. There was no doubt about the tissues being mammary gland tissue; the interest lay in the fact that they had been removed as tumors, regarded as such when grossly examined after operation, and the diagnosis of tumor confirmed microscopically.

The clinical analysis of these cases showed the following: Of 83 patients with fairly definite clinical histories, every one was found to have presented herself to the surgeon because of the presence of a "lump" in the breast. In 12 cases it was said to have "become tender" or to "cause trouble," to "get sore," or to be "tender." In 2 cases the pain is said to have coincided in time with the appearance of the menses. In 11 cases the lumps were "painless," "insensitive," or gave "no trouble." In 5 cases the appearance of the lumps was attributed to antecedent traumatism. In 5 cases there had been previous operations for the removal of similar lumps.

The resident physicians in the various hospitals described the lesions as "hard," "firm," "movable," "freely movable," "fibro-fatty," and "fibrocystic."

In size the lesions were said to compare with a goose egg, a grape fruit, an orange, a small orange, an apple, a hen's egg, a lemon, a lime, a plum, a walnut, a hickory nut, a pecan, a pigeon's egg, a marble, and a hazel nut. The size recorded by the first examiner did not always tally with that recorded by the later operator. In several cases the resident physician wrote that the breast of the patient contained "a small hard tumor" though the writer of the later notes added that a "large soft one" had been removed.

Although in nearly every case the first examiner noted that the lump was movable or freely movable, the surgeon rarely attributed that condition to "encapsulation." In only 6 out of 147 cases did the surgeon state that the tumor was encapsulated, and in only two others did he say "well circumscribed." In fact the descriptions given by the surgeons are interesting, and are as follows: "nodular mass" in 2 cases; "cysts" in 7 cases; "cystic" in 8 cases; "fibrocystic" in 2 cases; "fibrocystic tumors" in 6 cases; "fibro-adenomata" in 3 cases; "fibro cystadenomata" in 7 cases; "chronic cystic mastitis" in 2 cases; and in 35 cases it is stated that cysts, large or small, were present in the removed tissue.

It was hoped that the description of the operation might give some clue to the reason for regarding the removed tissue as from or as a tumor, but only vagueness was found: in 1 case the tissue was said to have been "enucleated"; in 1 it was "enucleated with scissors"; in 15 it was "dissected out"; in 25 it was "excised"; in 4 it was "shelled out"; in 18 it was "removed"; and in 2 it was "cut away."

The average pre-operative duration of these lesions was 1 year, 9 months, 1 week, and 3 days, the extremes being 18 years on the one hand, and 3 days on the other. Lesions varying between such extremes can scarcely be the same.

One would suppose that the more leisurely examination of the tissue after their arrival at the laboratory ought to straighten out errors resulting from a hasty glance by the surgeon at the moment of operation, but unfortunately it rather seemed to add to the confusion, for, as has already been pointed out, these tissues received no less than 33 different names, the

most popular of which were adenofibroma which was applied to 52, and fibro-adenoma, which was applied to 17. In one large hospital sections of normal breast tissue received 9 different designations, though they looked almost exactly alike. How could such a circumstance have arisen?

Tissues from the clinic usually reach the laboratory accompanied by some kind of blank form bearing some kind of general or special information, varying in usefulness and thoroughness in different hospitals, but unfortunately, usually woefully lacking in the information that the pathologist should have in order that his talents and experience be afforded full opportunity for accurate diagnosis and prognosis.

The identification blank may state that the specimen is a tumor, or a piece of a tumor removed from the breast. This results in a false start. Whether the pathologist sees what appears to be tumor tissue or not, it is said to be such and he may feel no discretion in the matter. He therefore proceeds with the study of the tissue from the wrong standpoint, and begins the establishment of a vicious circle: for having accepted the tissue as part of a tumor, he must find for it some appropriate name, and, for example, decides upon "fibro-adenoma." The surgeon, supposing that the pathologist knows, may be surprised to learn that he has removed a tumor, where only a cyst, for example, was supposed to have been, recalls the chief gross features of the tissue, and when he sees it again, may not only call it a tumor, but give it the same name, with which it now reaches the laboratory, to be confirmed. Thus each supports and confirms as well as deceives the other until a tacit understanding arises that certain appearances shall be called by certain names, whether scientifically appropriate or not. But the confusion becomes worst when the system of false nomenclature reaches the extreme, as, for instance, when a breast removed because of suspected carcinoma, but in which no tumor could be found, was reported as "fibro-adenoma," or when a small fragment of breast tissue adjacent to a cyst was called by the same name, although no tumor was suspected by the surgeon or found by the pathologist.

The reality of the situation cannot be better shown than by the finding of these 147 tissues all called tumors, not one of which was really a tumor, and by the acknowledgment of the pathologists in whose collections they were found that they were not tumors but only breast tissue. They are convinced of the error, but how long will it take to disabuse the minds of the surgeons of the misinformation they have received and satisfactorily explain the matter to them?

When the cases were discussed with the respective pathologists of the various hospitals in which the tissues were unearthed, in not a single case was the original diagnosis of tumor maintained after the obvious mistake had been pointed out.

But if the "lumps" were not tumors, how is their clinical tumor-like quality to be accounted for? What were they?

It may not be possible to answer these questions satisfactorily, because of the number of conditions that may occasion the occurrence of "lumps." In the first place it must be recalled that in 35 of the cases the presence of some kind of cysts is recorded. They are in themselves "lumps," but as they take up space at the expense of the mammary tissue proper, which is compressed and condensed by their presence, they suggest that other condensations may bring about similar indurations. For example: A young woman appeared with a "lump" in her breast. It was about a year since it had been discovered, and it seemed to be well circumscribed, firm, painless, insensitive, and freely movable. Under local anæsthesia the surgeon cut down upon it, and found a circumscribed and apparently encapsulated nodule that he removed with the greatest ease. He unhesitatingly made a diagnosis of "fibro-adenoma," which was confirmed by microscopic examination at the hospital laboratory. Later, however, when other sections were prepared, an area of tuberculous disease was found to be situated at the center of the nodule, and the diagnosis was very properly corrected to "tuberculosis" of the breast.

That this lesion was first called "fibro-adenoma" should not be overlooked. Eighteen out of 27 tissues from two hospitals, called by

that name, were non-tumors, and only 6 were tumors—periductal fibromata. It is excellent evidence of the abuse of the name, for if fibro-adenoma means periductal fibroma in 6 cases, and nothing in 27 cases, it has no meaning at all, and should be abandoned.

The other "lumps" may not all be explained; their causes were doubtless numerous and multifarious. One of 10 years' duration may have been entirely different from another known to have existed for only a few days or weeks; an insensitive lesion may have had a different explanation from another that was sensitive, or occasionally painful. Present inability to account for them indicates only how necessary it is for more careful studies of the breast lesions to be made, and how important it is for the exploration of the breast itself to be complete.

THE INDETERMINATE GROUP

The patients from whom the tissues thus denominated were removed, were women varying in age from 20 to 50 years, the average being 31 years. Some were married, some single. Plotting of the ages of 17 cases for which data was available, gave no curve of age incidence. The cases distributed themselves in small numbers throughout the whole period of sexual life, though none were very young.

If it had been possible to identify these tissues, the group would not have been created, some may have been tumors, some probably were not. It was supposed that the lesions bore some relation to the evolutional and involutional changes through which the mammary tissue passes in the course of its physiological activities. Histological appearances resembling these lesions were observed in some supposedly normal breasts, and called "fibromatoid involution."

But as the conditions were not identified, they must, at present, remain unknown. Fortunately they in no manner influence the main facts and conclusions resulting from this research.

CONCLUSIONS

1. Two hundred and eighty-nine cases, supposed to be benign fibro-epithelial tumors of the female breast, were studied clinically and pathologically, for the purpose of harmonizing and simplifying the nomenclature.

2. One hundred and five of them, described under no less than thirty-three different names, were found to be periductal fibromata.

3. One hundred and forty-seven, described under much the same names, showed no histological indication of being tumors, or in any way related to them, but were simply mammary gland tissue, either normal, or in some condition of involution.

4. A system of nomenclature that permits tumors and non-tumors to be given the same names is too faulty to be continued.

5. As all of the tumors resolved themselves into varieties of a single well characterized genus, it would be well to call them all by the same name, and that recommended as most appropriate is Warren's choice, periductal fibroma.

6. In all but 37 cases there was no difficulty in separating the tumors from the non-tumors.

7. The research having been conducted upon material collected from five large, first-class hospitals, where it had been studied by many different pathologists, may be regarded as fairly representative of pathological tissue work as commonly conducted in hospitals.

8. The mistake of calling non-tumor tissues by names belonging to tumors, may have been the result of overzealousness on the part of the pathologists to co-operate amicably with the surgeons.

9. There are anatomical and physiological mammary disturbances of the breast that may occasion "lumps" that have no relation to tumors, and the surgeons should be so informed and not led to believe that they have removed tumors when none existed.

10. Pathology must remain confused both in theory and application unless its terminology be so relieved of ambiguity as to be easily understood.

CHRONIC MENINGEAL (POST-TRAUMATIC) HEADACHE AND ITS SPECIFIC TREATMENT BY LUMBAR AIR INSUFFLATION; ENCEPHALOGRAPHY[1]

By WILDER PENFIELD, M.D., New York

From the Surgical Clinic of Professor Allen O. Whipple, Presbyterian Hospital

PATIENTS complaining of post-traumatic headache and dizziness have been rather unwelcome patrons of most clinics. They have often received financial compensation and are living in hopes of a further settlement. These facts, together with the absence of abnormal physical signs, may lead to an unmerited diagnosis of traumatic neurosis.

It seems obvious that many of these patients suffer from a very real though poorly understood complaint and until a method of treatment was stumbled upon we had been in the habit, in dispensary practice, of separating out the patients whose complaints were unquestionably real, under the diagnosis of meningeal headache.

The first of these cases was treated in 1922 and, although the cure was a complete one, the full significance of the result was not at that time realized, possibly because the procedure was undertaken from a diagnostic and not a therapeutic point of view.

As the result of my failure to interpret this first case correctly, no further attempt was made to relieve these sufferers of their headache until 4 years later. At about that time I discussed the matter with Dr. R. Wartenburg, who stated that he also had seen patients with headache relieved in the course of encephalographic studies.

Shortly after this conversation I saw the patient reported as Case 2. He was suffering from such excruciating headache that in March, 1927, lumbar air insufflation was undertaken in a frankly experimental effort to give him relief.

Case 1. A. L. Post-traumatic headache of 6 weeks' duration.

Four weeks before admission to the hospital the patient, a boy of 4½ years, fell from a second story fire escape and received contusions of the occipital region. He was drowsy for 3 days. After the accident he had continuous frontal headaches and was irritable. For a few days before admission the headache had become very severe and there was vomiting.

A linear fracture of the occipitoparietal region without depression was found by roentgenogram. Examination was otherwise negative.

Lumbar insufflation. (Spinal fluid clear, 6 cells, negative globulin, pressure with patient horizontal, 200 millimeters of water.) By lumbar puncture about 50 cubic centimeters of spinal fluid was withdrawn and replaced by 42 cubic centimeters of air, the removal and replacement being made alternately in 5 cubic centimeter amounts. Roentgenograms (pneumograms) taken at once showed a considerable collection of air over the right frontal pole of the cerebral hemisphere, in what seemed to be a circumscribed cyst. There were also a few bubbles in the intergyral sulci. On the following day, the air was all in this location with none left in the sulci (Fig. 1). There seemed to be atrophy of the underlying lobe as indicated by the thickness of the air collection. Whether this cyst was in the subdural or the subarachnoid space, it is difficult to determine with certainty.

Result. For a few days he had some headache. After that time he was entirely free from it and there has been no recurrence in the 5 years which have elapsed since the insufflation.

Case 2. F. G. Post-traumatic headache and dizziness of 18 months' duration.

In January, 1927, the patient, an automobile mechanic of 42 years, came to the Presbyterian Hospital Dispensary, with the following story. Eighteen months previously, he had been struck by an automobile and taken unconscious to the Harlem Hospital where they made a diagnosis of fracture of the skull in the right temporoparietal region. His spinal fluid was found at that time to contain much blood, and the Harlem Hospital records show that he complained of diffuse headache most intense in the right occipital region during his 3 weeks of hospitalization. From that time on he suffered from headache for 18 months and went about in desperation from one clinic to another seeking help.

Careful questioning brought out the following features of his complaint: The pain was situated over the right eye and forehead. It seemed to be a pressure behind the eye, and in addition there came sharp stabbing pain about every 5 minutes or at any time when he stooped over. This stabbing sensation would move quickly to the opposite side and then disappear. At night he sought relief by lying prone and resting his head on his left brow

[1]Read before the Medical Society of the County of New York, October 24, 1927.

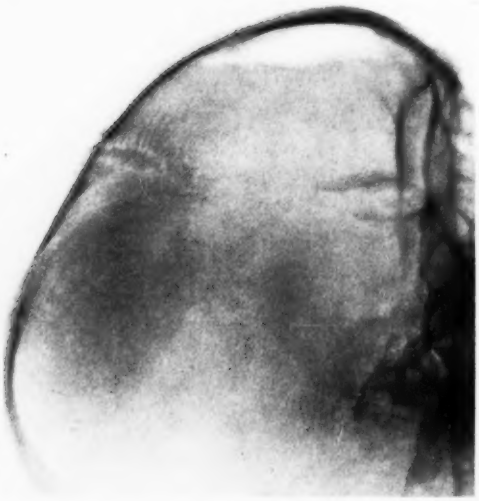

Fig. 1. Case. 1. Frontal headache. Roentgenogram taken with brow up 24 hours after lumbar insufflation.

but he slept very little. For about a half hour to an hour after getting up in the morning he might be free from pain. Stooping to put on his shoes would start the headache, he said, so his wife usually performed this task for him. In "heavy weather" the headache was particularly bad. He had some nausea usually in the middle of the morning and occasionally vomited.

Vertigo was present from the start. It would come on suddenly while he was walking and would pass off in 5 or 10 minutes. At such times he was in the habit of stopping and holding on to some object. He staggered to the left when seized by this sensation, never to the right.

On physical examination we found a temporal hemianopsia of the right eye which included the fixation point. In the left eye there was partial temporal hemianopsia. These findings suggested a direct injury to the optic chiasm. The optic discs were atrophied, the left pupil larger than the right, and there was partial failure of convergence, also nystagmus on gaze to the left. He had a partial paralysis of lower right facial muscles. The deep reflexes were normal as were the superficial reflexes, with the exception of slight under action of the left abdominal reflex.

The patient was seen on several occasions, and an effort was made to give him relief by prescribing glasses, sedatives, and other expedients but without avail. He could not work, could not sleep, and his family of seven was destitute. Finally, it was decided to try what seemed the forlorn hope of spinal air injection which had relieved the little boy 4 years before. He accepted the procedure as an experiment.

Fig. 2. Case 2. Headache behind right eye. Brow up, air in frontal subarachnoid spaces and interpeduncular cistern.

Lumbar insufflation of air was done with a provisional diagnosis of subarachnoid cyst. The patient was placed on his left side and lumbar puncture performed. The fluid was clear, contained 3 lymphocytes per cubic millimeter, 20 milligrams of protein per 100 cubic centimeters, 0.84 gram sugar, and 7.5 grams chloride per liter; Wassermann reaction was negative.

The head was elevated about 6 inches above his feet and turned so that the right frontal region was uppermost. Fifty cubic centimeters of spinal fluid was replaced by an equal amount of air in 5 cubic centimeter amounts. The patient immediately complained of severe pain in the right frontal region at the site of his usual headache.

Roentgenograms were then taken, rotating the head into the four routine positions. No air entered the ventricles but it passed freely through various portions of the subarachnoid space as a result of the rotations.

No cyst was seen in the plates taken on the first day (Fig. 2), but it was observed that the bubbles over the right frontal lobe were numerous and so broken up as to suggest atrophy of the right frontal

Fig. 3. Case 2. Brow up, 24 hours after insufflation, air in cyst.

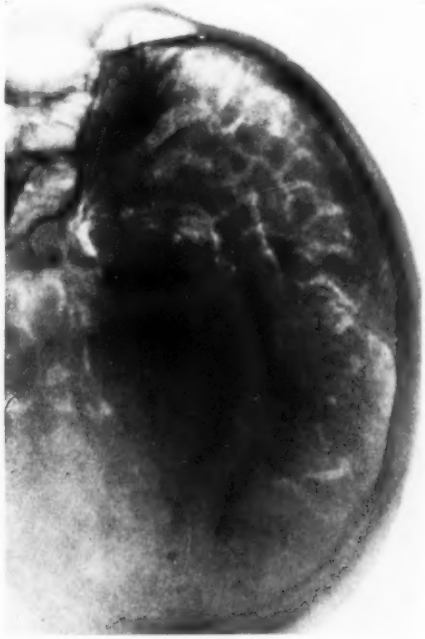

Fig. 4. Case 3. Left frontal headache. Brow up, air in frontal subarachnoid spaces, and a little in ventricle.

cortex or increased complexity of the subarachnoid channels for some other reason. Plates taken on the following day showed that the air outlining the sulci had disappeared, but there was a collection of air over the lateral aspect of the right frontal region with scattered bubbles about it. This collection remained here, even in the plates taken with brow uppermost (Fig. 3), showing that it was held in a cavity or partial cyst of some sort. There was no evidence of this cyst in the plates taken immediately after the insufflation, and one wonders if it had not been opened up by the excursions of air which must have accompanied movements of his head during the first 24 hours.

Result. Following the air injection he had a bad headache which was described as a feeling of pressure. This lasted an hour and a half. After this the headache disappeared and the following morning he felt much better and stated that he was able to sleep on his back instead of with face down for the first time in many months. During the following few days his headache disappeared altogether, both the dull ache in the right forehead and the sharp shooting pains. Moreover there was no more vertigo and no nausea.

He went in search of work at once and when seen 3 months after operation, he was doing heavy work as a porter, his eyesight not permitting him to take up his former duties as mechanic. At present, 9 months after the air injection, there has been no return of his headache. Vertigo has returned, however, and is experienced particularly during long walks. Also, when he leans over forcibly to either side, so that his head is carried rapidly to that side, he sometimes hears a curious sound, like rushing water as though one stood "at the foot of a waterfall." The amount of air injected was small in this case and even though the headaches have not returned it is probable that a second insufflation will be undertaken shortly.

CASE 3. J. W. Post-traumatic headache and dizziness of 6 months' duration.

The patient was a stone mason of 34 years. Six months before admission to the hospital, a scaffolding fell and struck him on the top of the head. He was unconscious 2 or 3 minutes. On the following day he returned to work and continued at it for 3 weeks. But during this time he had almost continuous headache which grew progressively worse until he was forced to give up work.

About 4 days after the accident he began to be dizzy, especially on rising from bed in the morning. This vertigo would come upon him, occasionally, at

Fig. 5. Case 3. Brow up, 48 hours after insufflation, air probably in subdural space, also in anterior horns of ventricle.

other times so that he was afraid to mount the scaffoldings where he was in the habit of working far above the pavements of New York.

The headache was dull in character and present in both frontal regions. It came on immediately after getting out of bed in the morning and disappeared about 11 or 12 o'clock to return for an hour in the late afternoon. It was made worse by coughing or blowing his nose. On several occasions blowing the nose produced clots of blood and once this was followed by a profuse discharge of clear fluid.

He was followed carefully and after several months had elapsed the headache seemed to lateralize to the left frontal region and was described as a "hammering." After 6 months of this the headache had decreased somewhat and he tried to return to work for 3 weeks. He found, however, that vertigo made him fear a fall and that whenever he exerted himself, as in lifting, he experienced a very severe pain in his head. He complained also of increasing deafness.

Physical examination was essentially negative except for reduction in hearing and evidence of earlier otitis media.

Lumbar insufflation. The spinal fluid was clear, horizontal pressure 150 millimeters of water. With the patient on his right side and the table tipped as usual, 95 cubic centimeters of fluid were removed in 5 cubic centimeter amounts and replaced with 84 cubic centimeters of air, keeping the fluid pressure about the same throughout. The left frontal region of the head was uppermost throughout the procedure. During the injection the patient complained of severe pain, at first frontal and later in the neck.

The pneumograms first taken, showed the well filled intergyral spaces over the left hemisphere to be quite normal in appearance (Fig. 4). However, the usual oscillations of the head designed to cause the air to pass to other portions of the subarachnoid space had that result to a limited extent only. Some of the air seemed to escape into the subdural space, as it outlined the falx and appeared as a compact bubble over the right hemisphere.

Plates taken after 48 hours showed no more intergyral air but a large bubble always present between brain and skull at its uppermost point (Fig. 5). There seemed to be some atrophy of at least one of the frontal poles as the air when it collected over this pole was of considerable thickness. It is difficult to be quite certain, but this air seemed to be in the subdural space rather than in a subarachnoid cyst.

Result. He complained of headache for several days after insufflation, particularly when he moved his head. On the ninth day, however, he was discharged entirely free from both headache and dizziness. Six weeks later he returned to say that he was still free from headache and that he was working on the fourteenth floor now where he could look directly down at the sidewalk beneath him. Even under these conditions he had felt no return of the vertigo.

Case 4. A. C. Post-traumatic headache and dizziness of 2 months' duration.

The patient, age 30 years, was the wife of a doctor and had formerly been a trained nurse. She was referred by Dr. Walter Phillips of Englewood.

Two months before admission to the hospital she had been in an automobile accident receiving abrasions of the face. There was probably no unconsciousness but from this time she complained of headache always localized in the left frontal region.

For the first 2 weeks, which were spent in bed, she was dizzy on raising her head from the pillow. After this, vertigo was felt only occasionally and for no apparent reason. This did not cause her to stagger but she usually sat down until it passed. She occasionally experienced a feeling of being "dazed" and "far away" even while sitting quiet, as for example at a game of cards.

The headache was described as "pounding" and "like a weight." It always was located in the left frontal region. Occasionally she felt a sharp stabbing pain of very short duration in the top of her head. The headache though constant was made worse by stooping or fatigue and became regularly more intense in the late afternoon.

Lumbar insufflation. (The spinal fluid was clear, horizontal pressure 180 millimeters of water, 3 cells,

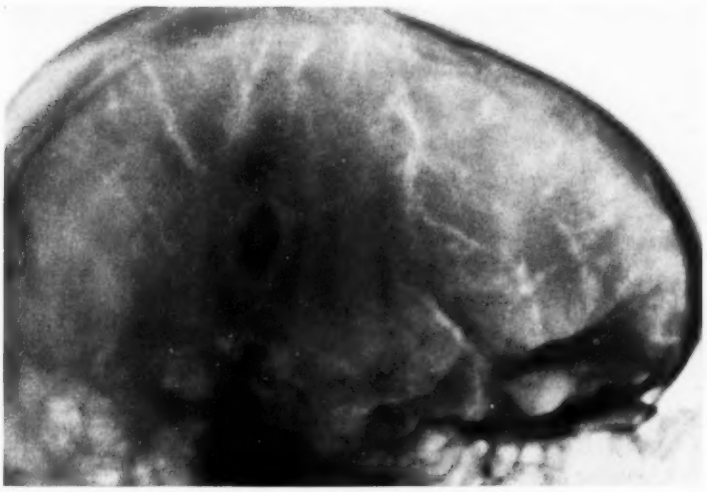

Fig. 6. Case 4. Right side of head up. Air seen in subarachnoid spaces and interpeduncular cistern.

normal globulin, total protein 23 milligrams per 100 cubic centimeters.)

In 5 cubic centimeter amounts 70 cubic centimeters of spinal fluid were replaced by an equal amount of air. There was renewed pain in the left frontal region with each injection of air, the patient being on her right side with head raised. During head oscillation this pain was felt in the right frontal region as well.

The pneumograms showed some widening of the subarachnoid fissures over the frontal lobes of both sides, especially the left, suggesting slight atrophy (Fig. 6). Even the first day there may have been some escape into the subdural space (Fig. 7). But 2 days after insufflation the intergyral air had disappeared and was definitely collected in the subdural space, being particularly easily seen over the frontal poles (compare Figs. 8 and 9).

Result. For 8 days following the insufflation the patient complained bitterly of pain which came on with each movement and was apt to be localized in the uppermost portion of the head. On the ninth day the headache disappeared for the first time since the accident and has not returned up to the present, a period of 5 months. The vertigo likewise vanished completely, and she is in perfect health.

CASE 5. M. F. Headache and dizziness of 8 years' duration.

The patient was a woman of 65 years who had been in an automobile accident 8 years previously and received a fracture of the skull and of one femur. The resultant unconsciousness lasted for 3 weeks after which she had difficulty with memory and some aphasia for several months. There was a laceration in the left frontal region and frontal headache and dizziness were severe for 2 years after the accident. At the end of that time a lumbar puncture was done. The headache became worse for 3 days and then almost disappeared. The dizziness was not affected.

During the past 6 years since the puncture she has complained of gradually increasing severe neuralgic pains in the frontal region usually on the left. This was associated with occasional dull frontal headaches which became almost continuous for several weeks before admission. Dizziness had also come to be almost constant and resulted in several falls.

The physical examination was negative except for paresis of left sixth cranial nerve.

Lumbar insufflation. Lumbar puncture which was performed by Dr. W. Cone showed a pressure of 200 millimeters of water. The fluid contained 11 cells, had a faintly positive globulin and negative Wassermann test and normal amounts of sugar, chlorides, and protein. With the patient on her right side and the head of table elevated, 80 cubic centimeters of spinal fluid was replaced by air in 5 cubic centimeter amounts. There immediately resulted severe pain in the left frontal region with some vomiting.

The pneumograms showed very irregular, wide subarachnoid intergyral sulci with a good deal of brain atrophy (Fig. 10), most marked in the vicinity of the left fissure of Sylvius. As the head was rotated into different positions and oscillated in each position air bubbles remained caught in the arachnoid sulci (Fig. 11) instead of passing freely to an uppermost position as is normally the case. It could be seen in the last plates to be taken on the day of the insufflation (i.e. in those taken after much movement of the

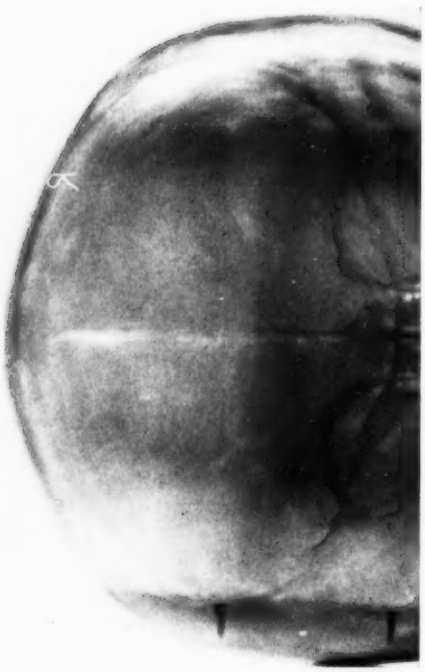

Fig. 7. Case 4. Right side of head up. Air in subarachnoid and subdural spaces.

head) that much of the air had apparently escaped into the subdural space (Fig. 12). Two days later all of the air seemed to be in the subdural space (Fig. 13).

Result. The operation was immediately followed by cessation of the vertigo. The headache was increased for a few days and then disappeared completely. Three months later there had been no recurrence of the sharp head pain. At this time the vertigo was still remarkably improved, being experienced only on rising suddenly from a sitting position.

CASE 6. P. C. Post-traumatic headache and dizziness of 10 months' duration.

The patient is a carpenter of 32 years referred by Dr. H. Osserman. Ten months before admission to the hospital he was struck on the back of the head by a descending elevator. He was unconscious for 5 minutes. Next day he had generalized headache most intense over the occipital region. He remained in bed most of the time for 5 weeks.

The headache continued steadily during the 10 months before his admission, although it grew somewhat less intense. It was situated over the occiput and radiated forward on the right to the parietal region. It was dull in character. There were never any sharp pains. The ache was worse in stormy or hot weather. Occasionally, he had a day free from headache. He was almost invariably awakened by the headache about 1 or 2 o'clock in the morning and was then in the habit of getting up to seek relief in smoking. He frequently could not get back to sleep at all after this.

During the first few weeks he experienced what he characterized as "lightness in the head" each time he got up. At these times he thought he would faint. The sensation lasted from 2 or 3 to 10 minutes. Since that time the vertigo has most often come on when rising from his chair. On one occasion he had a bad fall when such a sensation came over him as he stood at the head of the stairs. He stated that, when "lightness of the head" affected him while reading, his vision was temporarily blurred.

Spinal insufflation. (Spinal fluid clear, 55 cells per cubic millimeter, globulin negative.)

Lumbar puncture was performed and 70 cubic centimeters of fluid replaced by an equal amount of air in 5 cubic centimeter amounts, after the patient was placed on his left side, on a slanted table. The patient's head was rotated, so that the brow was down in order to cause filling of the cisterna magna and cerebellar arachnoid. He complained of pain, first in the thorax, then in the back of the head and right ear. After 30 cubic centimeters of air had been injected the head was rotated so that the brow was slightly above the occiput. The pain then spread upward to the right parieto-occipital region following the movement of the air. When the head was oscillated for the purposes of roentgenography, the pain left this region and was in general complained of at the uppermost portion of the head.

Pneumograms showed the subarachnoid space well filled and approximately normal in appearance. The cisterna magna was well outlined and air had entered the ventricle in considerably larger amount than is usually the case, doubtless due to rotating the face down at the beginning. On the second day the air was present in almost exactly the same amount in the ventricles but had vanished from the subarachnoid spaces including the cisterna magna.

Result. On the second day following the insufflation, the patient remarked that he had slept through the night for the first time in 10 months. The "old headache" disappeared but he continued to have headache which moved about, for 8 days. When he sat up the headache was at the top of his head. After 8 days most of which he was kept in bed he was discharged on the ninth day free of headache and dizziness.

CASE 7. W. M. Post-traumatic headache and dizziness of 1 month's duration.

The patient, a carpenter of 32, was struck in left mastoid region 1 month before admission. He was not unconscious. He continued at his trade for a few days when he was advised to stop and be as quiet as possible. About the second day, headache and dizziness began. The headache was bifrontal from the start and felt like a dull pressure. The vertigo was apt to come on suddenly and last only

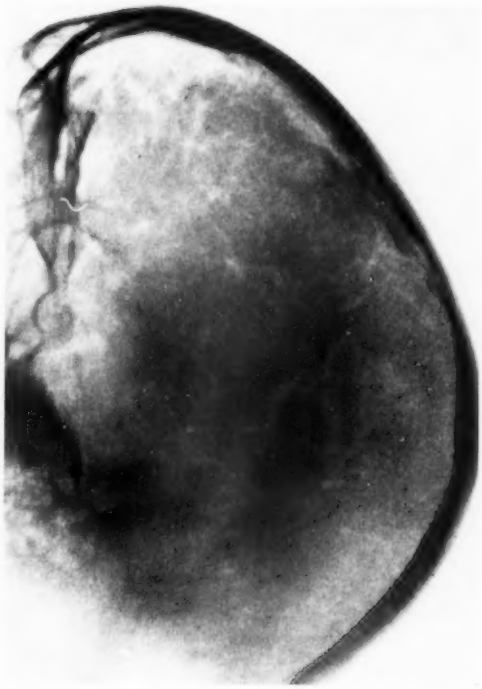

Fig. 8. Case 4. Brow up, showing air in the subarachnoid spaces.

Fig. 9. Case 4. Brow up, 24 hours after insufflation, air in subdural space.

a few minutes. Occasionally he had the sensation of receiving a blow in the forehead with a hammer. The pain then seemed to spread back over his head subsiding gradually until the blow came suddenly again.

On examination he was found to have decreased hearing in the left ear, while bone conduction was louder than air on that side. There was fine nystagmus on gaze to the left. Otherwise examination was negative.

Lumbar insufflation. The pressure of spinal fluid when table was horizontal was 120 millimeter water, cells 4, globulin negative.[1] With the patient on his left side his brow being rotated up and table inclined, 75 cubic centimeters of fluid was replaced with 70 cubic centimeters of air in 5 cubic centimeter amounts.

At the close no more spinal fluid could be removed. He complained of generalized headache most severe in the frontal region. There was profuse diaphoresis and he vomited while he was on the table and several times during the head rotations for pneumography. The pulse fell to 50.

[1] Lumbar puncture 4 days later showed a pressure of 150 millimeters of water, 289 red cells, 6 lymphocytes, and 3 polymorphs per cubic millimeter and faintly positive globulin.

Result. The patient continued to have headache after the insufflation. It was different in type and it moved about but it gradually subsided. He was kept most of the time in bed for 8 days so that the air might continue to move over the hemispheres. On the ninth day he was discharged feeling "like a new man" and free from headache. The vertigo which had come on two to three times a day before insufflation was not felt again afterward.

SUMMARY OF CASES[2]

Seven cases of post-traumatic headache and dizziness have been presented. All of them have been relieved of their headaches completely although Cases 6 and 7 are too recent

[2] In addition to its use in selected cases as a diagnostic aid, lumbar insufflation has been undertaken by me for the specific purpose of relieving headache in only two additional cases not reported above. One of these gave symptoms similar to those of the post-traumatic cases but her headaches had followed a chronic mastoid infection and the relief, although marked, was not complete. The other case was that of an Italian who spoke such broken English that it was impossible to be certain whether or not his complaints fitted into the syndrome of meningeal headache. He stated that his pain was improved after the insufflation but complained still of backache. One could not be sure that his improvement was not due to suggestion, and the whole case was so difficult of study that it is not included here.

Fig. 10. Case 5. Frontal headache. Right side up, 8 years' standing. Air in subarachnoid spaces, showing cyst formation and cerebral atrophy.

to permit a conclusion as to the permanency of their relief. All were enabled to resume their normal activity by day and to sleep soundly by night.

Of these 7 cases, each complained of some type of vertigo with the exception of the little boy (Case 1) who was probably unable to put the complaint into words, being only 4 years of age. Each of the 6 cases was relieved of his vertigo at once but in one patient (Case 2) occasional vertigo has returned. Only 50 cubic centimeters of air was used in this patient and a re-injection will probably be done.

The ages of the patients varied from 4 to 65 years. In each case the complaints dated from the time of a head injury which had occurred from 4 weeks to 8 years earlier. In 2 cases there was no loss of consciousness but in the others unconsciousness was of variable duration, from 2 minutes to 3 weeks. In only 3 of the 7 cases could a fracture be proved. In 3 cases the site of the headache corresponded with the site of the blow. In 3 others the pain was frontal, although the blow struck the occiput in one instance, the vertex in a second, and the parietal region in the third.

The amount of air injected varied from 42 to 95 cubic centimeters. The immediate reactionary headache lasted from 3 or 4 up to 9 days after insufflation.

The pneumograms showed a cyst of the pia-arachnoid in three cases at least. There was frank escape of the air into the subdural space in three cases.

LUMBAR AIR INSUFFLATION

The technique as we have employed it differs somewhat from that of those who make use of it for encephalography only. In the first place we do the procedure in the operating room with complete aseptic precautions. The patient may be given ¼ grain of morphine at the start and should receive more later if necessary, or scopolamine may be used with morphine (Strauss and Friedman).

If the location of the headache is right-sided, place him on his left side on a horizontal table. Do a lumbar puncture and measure the spinal fluid pressure. Then tip the table so that the head is approximately 30 to 40 centimeters above the feet. If the headache is in the middle or anterior thirds of the head, rotate the brow up about 45 degrees or less. In this position, air passes directly to the fronto-parietal region via the basal cisterns, very little entering the ventricles. If the brow be rotated sharply downward, the cisterna magna may be filled and air usually enters the ventricles.

Withdraw fluid in 5 cubic centimeter amounts, alternately injecting after each with-

Fig. 11. Case 5. Brow up, air in subarachnoid spaces and interpeduncular cistern.

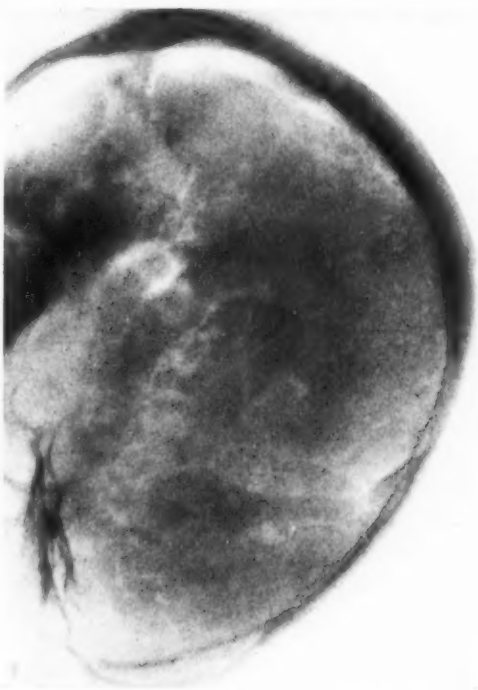

Fig. 12. Case 5. Occiput up. Air in subarachnoid and in subdural space above and below tentorium.

drawal 5 cubic centimeters of air which is filtered through cotton. The whole system of tubing is connected by stopcocks in a closed system. Thus conditions are perfectly controlled and with a tight fitting syringe the amounts of air injected or fluid withdrawn can be controlled with ease.

About 100 cubic centimeters of air or less may be thus injected and it will completely fill the cerebral arachnoid spaces and basal cisterns. At the close the pressure should be about normal.

Without altering his position, the patient is sent to the X-ray room where horizontal and perpendicular plates are made in each headposition as by the usual routine (8). Thus the first two roentgenograms show air only over the convexity of the uppermost cerebral hemisphere. Before radiographing the head in each new position (i.e. occiput up, other side up and brow up) the head is oscillated thoroughly so that the air is carried through all parts of the subarachnoid space before the end of the procedure.

The patient should then remain flat in bed until the insufflation headache has entirely disappeared.

It has been our custom to raise the head of the bed on low shock blocks. In such a position each time the head is turned the air bubbles move over the hemispheres to the uppermost point as indicated often by the migrating local pain.

The side of the head where the headache was habitually most severe should be kept uppermost for the most part. If the patient be allowed to get up or sit erect, the air goes to the vertex and remains there moving little with head rotation. Therefore the erect position is prohibited for a few days after insufflation. With the absorption of the air the headache likewise disappears.

Fig. 13. Case 5. Right side up, air in subdural space outlining hemisphere and falx.

LITERATURE

Roentgenography of air which had been introduced into the cerebrospinal passages both by the ventricular and the lumbar route was first described by Dandy (4, 5) under the name of ventriculography. This procedure has come to be a most valuable diagnostic aid particularly for localizing cerebral tumors. Bingel (1) under the more completely descriptive term of encephalography was the first to use the method in Germany where lumbar air insufflation has been used very widely for more complete study of various types of affection of the central nervous system.

Thus, air insufflation has been largely an aid to roentgenography. On the other hand, Foerster (6) when relating his experience with encephalography mentioned the two following cases in which there was a therapeutic effect:

Case 39 was suffering from left-sided headaches following a blow on the head. Encephalography showed the ventricles pulled to the left, and he observed that the headache and dizziness did not return after the procedure.

Case 41 had had a severe blow on the side of the head after which there was a long period of unconsciousness. On recovery from the immediate effects of the blow the patient continued to have occasional attacks of transient hemiparesis and coma. These attacks were ushered in by headache, dizziness, and evidences of increased intracranial pressure.

Encephalography showed unilateral enlargement of the ventricles and large patches of air over the cortex which it was believed, indicated "post-traumatic cystic arachnitis serosa." He advised operation, but the patient felt so well after air injection that he refused.

Wartenburg (10) in 1926 described a case of coma secondary to subdural hæmatoma which seemed to be temporarily much improved by encephalography. He urged that encephalography may have a therapeutic effect on post-traumatic cases although he does not mention headache specifically but refers to the Case 41 of Foerster mentioned above.

Schwab (9) came very close to the subject of this communication when he read a paper

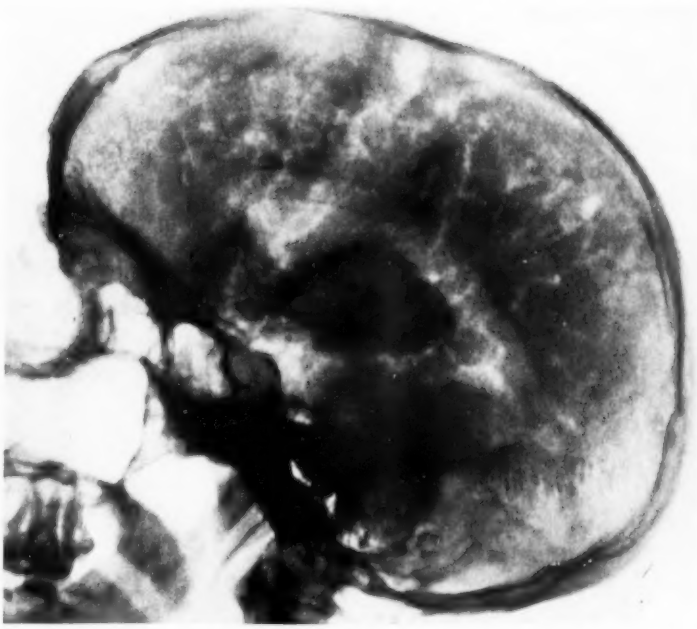

Fig. 14. Case 6. Right occipital headache. Air in ventricle and subarachnoid space.

on the "Encephalographic picture of the so-called traumatic neuroses" before the society of German neurologists in 1925. He pointed out that in such cases air might demonstrate a variety of abnormalities of the ventricles and meningeal spaces. And it is interesting to note that in a few of his cases there was air over the surface of the cerebral hemispheres, which, to judge by the description, may have entered the subdural space.

In reporting 7 cases, Schwab stated that all complained of headache, dizziness, tenderness of skull, decrease in power of attention, general drowsiness and fatigue, sleep disturbance and at times intolerance to alcohol. But he mentions no therapeutic improvement. His encephalography was done in a different manner with the aim of filling the ventricles whereas we have made a point of completely filling the subarachnoid space. This and the after-treatment may perhaps account for the absence of therapeutic affect in his cases.

He maintained that arachnitis serosa accounted for most of the abnormal phenomena of these patients and in the extended discussion which followed the paper it was generally agreed that arachnitis was the underlying pathology of the organic post-traumatic disturbances. It was energetically pointed out by some of the discussers that Schwab's cases should not have been diagnosed traumatic neurosis even without encephalography. But throughout the discussion there is no mention of the fact that air insufflation may be used as a specific therapeutic agent for some if not all of the complaints which the patients under consideration presented.

On the other hand Carpenter (2) in 1926 pointed out that in a series of cases studied routinely by ventriculography (direct ventricular injection), 3 patients who were chronic sufferers from headache of an unknown nature were relieved of their pain. In the history of only one of these cases previous head injury was mentioned.

A year later Carpenter (3) reported 40 cases studied by encephalography (spinal injection). Twenty-three of these proved to

have brain tumors. Three cases of unexplained chronic headache were relieved after being so studied. Again no relation to trauma is mentioned.

Of these 3 cases, the first was a woman of 24 who had suffered from headaches at intervals for 4 years and had been confined to her bed for 4 months. She has been cured one year.

The second case was that of a girl of 28 who had suffered from agonizing attacks of occipital pain and vertigo for 3 years. There was also disturbance of vision, ataxia, and paræsthesia of the right side. She was apparently relieved and returned to work after 2 months' rest treatment.

The third case of favorable result was in a woman who had suffered from headache for 12 years but she is apparently also included in the previous report (2).

Thus, to sum up the literature, Foerster has reported 2 cases of relief of headache in both of which the etiology was trauma, although headache and dizziness were not the only symptoms. In the 5 cases of Carpenter, trauma was a factor in one and possibly in others, as the histories are not complete. Evidently neither worker has differentiated the type of headache which may be relieved. In each case the improvement was incidental to diagnostic study.

PATHOLOGY

Head trauma is the obvious cause of the syndrome in each of the reported cases and the development of headache does not seem to have been influenced very much by treatment as 4 out of the 7 spent from 2 to 4 weeks in bed after the accident.

As was pointed out above, there was pneumographic evidence of atrophy of the convolutions in some cases. In 3, there was quite evident escape of air from the subarachnoid into the subdural space. In two or perhaps three there was a definite subarachnoid cyst seen.

The fact that a certain group of headache cases seems to be curable by a specific form of treatment, singles these headaches out from all the others and makes it likely that they are caused by a common mechanism. This mechanism obviously has to do with an abnormality in the cerebral meninges. Whether this abnormality may be an alteration in the normal circulation of cerebrospinal fluid caused by cysts, or fine meningeal adhesions, or whether the pain and vertigo have some other mechanical explanation will not be discussed in this communication.

It has been held by Foerster and others that a cystic arachnitis serosa is responsible for such post-traumatic symptoms as our patients gave.[1] If that be true the air which often forms a bubble of large size must separate the filamentous adhesions of such a condition. The abnormality, whatever it is, is obviously a mechanical one, but it seems better for the moment to accumulate further data before venturing an explanation of the underlying pathology.

SYNDROME

At present it is important to provide a description that will make possible the recognition of those cases susceptible of cure by air insufflation. All headaches obviously can not be thus cured and the indescriminate use of the method not only would cause unnecessary suffering but might well prove to be dangerous.

Headache and dizziness may be taken as the cardinal symptoms. The headache is invariably localized. It may spread to a certain extent but it is definitely referred to one particular part of the head. The location of the ache has most often been frontal but this seems to depend a good deal on the site of the trauma. In most cases the pain was situated near the site of the blow with some tendency to radiate forward. In one instance the headache was right frontal, the blow being upon the occiput.

The character of the headache is usually described as dull. Three patients described it as hammering and a fourth seemed to feel the occasional impact of a hammer. Three have complained of fleeting sharp pains at the site of the headache like the stab of a needle. Ordinarily the pain is made worse by lifting, blowing the nose, or stooping although this is not invariable.

[1] Horrax (7) has pointed out that in addition to trauma, an inflammatory process has been assigned as the cause of such an adhesive condition.

The headache is usually present every day. It often has diurinal variations coming on shortly after rising from bed and reaching its apex in the latter part of the morning, sometimes becoming troublesome again in the late afternoon. In one case it became most troublesome after midnight. Some patients can not sleep because of it, while others are free from pain at night. Most of them are influenced unfavorably by stormy weather and some by hot weather.

The vertigo was present from the start in all but one instance where it appeared on the fourth day following the trauma. The sensation has been described often as "lightness in the head," once as a far away feeling. It lasts for several minutes without any sense of rotation. Moreover, the patients do not typically show nystagmus or other evidence of a vestibular lesion.

Vertigo may come on while patient is walking or on his rising from a chair or any time at all, so that the patients find it necessary to seize hold of something quickly and fear to go up on high places. This fear is justified by the fact that three patients have had bad falls.

In general there are no physical signs typical of meningeal headache. Two cases have shown some evidence of brain injury received at the time of the accident. At least 3 of the patients received skull fractures and all but 2 of them were unconscious for a variable period of time, immediately after the blow.

Finally, the diagnosis of meningeal headache may be made in the absence of abnormal physical signs when there is a history of localized, dull, hammering headpain associated with transient attacks of vertigo, and all dating from a head injury.

To be sure the number of cases in the series is small and the follow-up on some of them short. Nevertheless there is a striking similarity in the patient's complaints which seems to justify the recognition of these complaints as a syndrome. The uniform relief which lumbar air insufflation has afforded in all of the patients thus treated is gratifying testimony for the specificity of the treatment. Insufflation, however, must not be looked upon as free from danger and its indications and safeguards should receive careful consideration.

BIBLIOGRAPHY

1. Bingel, A. Encephalographie, eine Methode zur Roentgenologischen Darstellung des Gehirns. Fortschr. a. d. Geb. d. Roentgenstrahlen, 1921, xxviii, 205.
2. Carpenter, E. Surgical Treatment of Chronic Headache and Pain in the Head. Southwestern Med., 1926, x, 61.
3. Ibid. Encephalography. Am. J. M. Sc., 1927, clxxiii, 333.
4. Dandy, W. Ventriculography following the injection of air into the cerebral ventricles. Ann. Surg., 1918, lxviii, 5.
5. Ibid. Roentgenography of the brain after injection of air into the spinal canal. Ann. Surg., 1919, lxx, 397.
6. Foerster, O. Encephalographische Erfahrungen. Ztschr. f. d. ges. Neurol. u. Psychiat., 1924, xciv, 515.
7. Horrax, G. Generalized cisternal arachnoiditis simulating cerebellar tumor. Arch. Surg., 1924, ix, 95.
8. Penfield, W. Cerebral pneumography; its dangers and uses. Arch. Neurol. & Psychiat., 1925, xiii, 580.
9. Schwab, O. Encephalographische Bilder "sogenannter" traumatischer Neurosen. Deutsche Ztschr. f. Nervenh., 1926, lxxxix, 44.
10. Wartenburg, R. Beitrag zur Encephalographie und Myelographie. Arch. f. Psychiat., 1926, lxxvii, 507.

MALIGNANT INTRACRANIAL ENDOTHELIOMATA[1]

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THE predominating types of intracranial neoplasms are gliomata and so-called dural endotheliomata. The former have been analyzed by Cushing and Bailey with a view to establishing a gradation of relative malignancy, but the latter have long been considered, clinically, surgically, and pathologically, as relatively benign. However, in a review of the cases in the Mayo Clinic several significant factors were noted which led to the impression that all such neoplasms are not benign, but that a small percentage present the characteristics of malignancy.

MacCarty points out that few neoplasms are absolutely benign. All new-growths, regardless of the tissue involved, are relatively malignant or at least possess malignant potentialities; an index to the relative malignancy rests with the cellular differentiation.[2]

If the cells are fully differentiated into the special tissue which it is attempting to imitate, the tumor is relatively benign. But if it contains undifferentiated cells it should be considered active and regarded with suspicion. The activity of a tumor does not in itself designate malignancy, but it signifies that it is growing and the degree of cellular activity indicates the rapidity of growth. Mitotic figures are also an index of the cellular growth. The three stages of activity are (1) hypertrophy of the cells, (2) hyperplasia or an increase of embryonic undifferentiated cells, and (3) migration or invasion of the surrounding tissue by embryonic cells. These stages mark the metamorphosis of a benign into a malignant tumor. Thus a slow-growing encapsulated neoplasm, in which there is a predominance of partially differentiated cells, few mitotic figures, and a tendency to break through the surrounding capsule, should be considered as relatively malignant.

It is generally believed that intracranial endotheliomata are encapsulated, that they compress but do not invade the brain, and seldom metastasize. They do, however, frequently invade the dura and overlying cranial bone, and if the involved dura and skull are removed at operation the tumor will not recur. Such tumors are supposed to arise from nests of arachnoid cells and from cells accompanying the arachnoid villi which pierce the dura and project into the venous sinuses. Primary intradural endotheliomata are of two types: (1) a spherical or oval tumor, embedded in the substance of the brain with variable attachment to the dura; and (2) endothelioma *en placque* having broad attachments to the dura and producing only slight indentation of the surface of the brain. Cranial hyperostosis or hemicraniosis occurs frequently with intracranial endothelioma. Cushing believes that this occurs in tumors of the frontal and temporal regions, particularly if they originate near the falx. He also believes that the second type, endothelioma *en placque*, is more likely to produce this condition. He found endotheliomatous invasion of the thickened bone and believed this thickening to be due to the stimulating effect of the invading tumor. Phemister describes two types of cranial hyperostosis, a thickening and a local erosion. Localized bony thickening was present in 25 per cent of Cushing's series of 80 cases of meningeal endothelioma. Penfield, in reporting 10 cases of cranial and intracranial endothelioma in which hemicraniosis was associated, stated that whatever the etiology of these tumors, the cranial prominence is secondary to the invasion of the skull by the intracranial tumor. He also stated that neoplasms of this type do not show a tendency to local recurrence after their removal even though the scalp and muscle are invaded, nor do they manifest a tendency to form a fungus if they are only incompletely removed.

The histological nature of intracranial neoplasms has been investigated for many years because they were first classified with the heterogenous indeterminate group of endotheliomata if they could not be definitely

[2]A biological term referring to the structural changes.

[1]Submitted for publication, May 4, 1927.

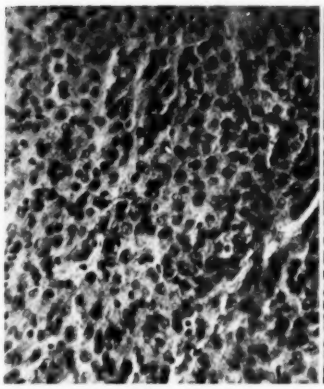


Fig. 1.

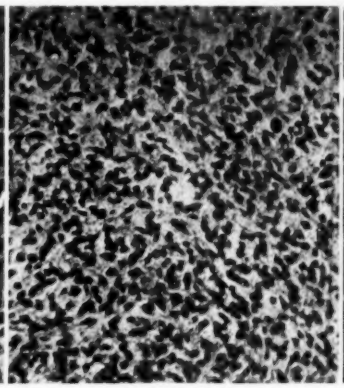


Fig. 2.

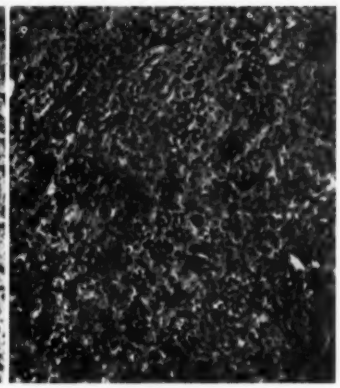


Fig. 3.

Fig. 1. Case 1. Many multinucleated cells are shown, undifferentiated and not conforming to any regularity of structure, a few embryonic cells with large single nuclei, and many mitotic figures scattered throughout. Malignancy is graded 4.

Fig. 2. Case 3. Cellular neoplasm showing undifferentiated cells of varying size and not conforming to any regularity of structure. Mitotic figures are scattered throughout. Malignancy is graded 3.

Fig. 3. Case 5. Cellular neoplasm containing embryonic cells of varying size and nuclei of varying character. Few mitotic figures are present. There is no regularity of structure but some attempt at differentiation. Malignancy is graded 2.

separated structurally into epithelial and connective-tissue growths. This large group has been gradually reduced by the more definite classification of many of them. Originally such tumors were supposed to arise also from the endothelial layer which lines the dura. This has been proved fallacious, and the origin has been definitely attributed to the arachnoid either alone or in combination with the pia.

To those of us who are attempting to classify and name these intracranial tumors satisfactorily, the situation is further complicated. Mallory, from the standpoint of connective-tissue structure, has called them "arachnoid fibroblastomata." Cushing, assuming that they arise from the meningioblasts, has called them "meningiomata." In accordance with these views, Oberling has advanced the hypothesis that the leptomeninges are formed from meningioblasts, arranged in an extensive syncytium extending between the nervous parenchyma and the dura, and that the meningioblasts take their origin from the neuroglia. This would lead to the assumption that the tumors are derived from the leptomeninges and fundamentally from the neural tube which is ectodermal in origin. In further justification of this view, Learmonth quotes Harvey and Burr as having recently conducted some convincing experimental work on the basis that these tumors arise from the arachnoid, which is epiblastic.

Thus it appears that the term endothelioma is a misnomer and should not be used. However, for purposes of convenience and to avoid difficulties of interpretation, I shall adhere to this term.

A review of the gross and microscopic pathology in the Mayo Clinic series of 56 cases of intracranial endothelioma revealed two significant facts: first, that a definite small group of cases were set apart from the usual picture of benign encapsulated tumors; second, that they showed cellular activity with areas of embryonic undifferentiated cells and mitotic figures. Some of them also showed invasion and a breaking through of the surrounding capsule not only into the skull and scalp but also into the underlying brain cortex. Associated with the pathological picture was the clinical history of a rapid increase in the severity of symptoms; hence the assumption that these neoplasms are malignant. Originally the tumors may have presented the classical picture of benignity, and yet at operation have proved to be malignant both grossly and microscopically.

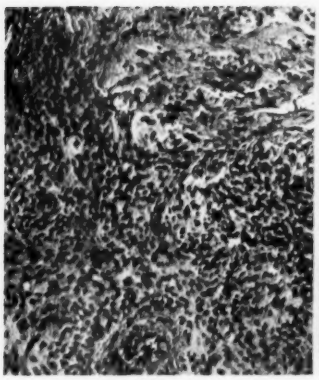
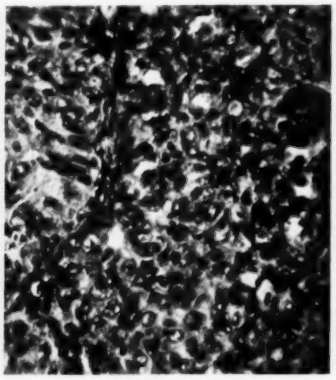


Fig. 4.



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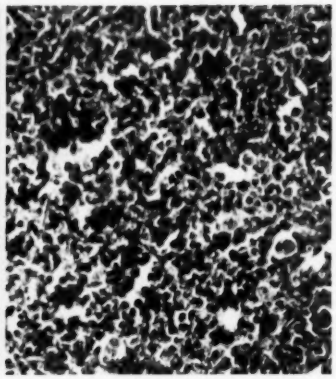

Fig. 6.

Fig. 4. Case 6. Cellular growing neoplasm showing an attempt to form whorls. The cells are partially differentiated and there are few mitotic figures. Grade 1.

Fig. 5. Case 7. Many undifferentiated cells with deeply staining nuclei and many mitotic figures are shown. Malignancy is graded 4.

Fig. 6. Case 10. Cellular tumor with undifferentiated cells and many mitotic figures. Malignancy is graded 4.

ILLUSTATIVE CASES

CASE 1. A man, aged 40, came to the Mayo Clinic complaining of numbness and weakness of the extremities on the right side, which he had noticed about a month previously. Coincidentally with this his vision failed. He also complained of a lump over the posterior parietal area on the left side of the head which had been present for a number of years and had recently increased in size.

Examination revealed weakness of the entire right side of the body. Urine and blood were normal. The Wassermann reaction was negative. A decrease in vision, bilateral choked disk of 3 to 4 diopters, and right homonymous hemianopsia were noted. Roentgenograms of the head showed marked thickening of the posterior parietal area on the left. Neurological examination showed slight weakness of the right side of the face and decrease in speed, tonus, and strength of the extremities on the right side. There was definite inco-ordination, with mild ataxic gait and tremor on the right side. A diagnosis was made of parasagittal endothelioma of the left parietal area and exploration advised.

A skin flap was dissected from over the osteoma and the endothelioma while the overlying bone which it had invaded was resected. It was necessary to resect the longitudinal sinus and to remove a portion of the falx. The capsule disclosed numerous invasions and extensions into the surrounding brain cortex. The tumor was very cellular (graded 4) and through it were scattered many mitotic figures. The cells were embryonic and undifferentiated, some containing large deeply-staining nuclei, and others multinucleated (Fig. 1).

CASE 2. A man, aged 30, came to the Clinic complaining of headaches, which had persisted for a year. One month previous to the onset of the headaches he had received a severe blow over the left frontal area in a railroad wreck. The headaches, which were associated with blurring of vision, occurred every 3 or 4 days, coming on in the early morning while the patient was in bed. The symptoms were increasing in severity. There was no nausea or vomiting. For 3 months previous to his examination he had gradually become dull and apathetic. About a week previously a lump had appeared over the left frontal region.

Examination did not reveal outstanding abnormalities except a small, pulsating tumor over the left frontal area. The urine was normal. The hæmoglobin was 73 per cent, leucocytes numbered 10,000, and erythrocytes 4,910,000. The blood and spinal fluid Wassermann reactions were negative, and the cell count of the spinal fluid showed the presence of 3 small lymphocytes. Vision in the right eye was 6/20 and in the left 6/30; the right pupil was larger than the left; examination of the fundi showed a choked disk of 2 diopters. Roentgenogram of the head showed marked erosion of the left frontal bone. The results of the neurological examination were practically negative except for bilateral decreased patellar reflexes. In view of the soft tumor in the left frontal region, the change in personality, and the choked disk, a diagnosis was made of endothelioma and exploration advised.

The tumor proved to be a malignant endothelioma which had eroded the skull; it was definitely encapsulated and projected into the left frontal lobe. Many dural metastatic nodules were noted. The cellular tumor (graded 3) contained cells of various sizes and many mitotic figures. It was growing rapidly and although encapsulated would have broken through before long, as evidenced by the metastasis or implants.

CASE 3. A man, aged 22, had noted diplopia and failing vision for the previous 3 weeks. For 2 years,

Fig. 7. Case 3. Encapsulated surgically-benign tumor which was completely removed. It is definitely malignant (Fig. 2).

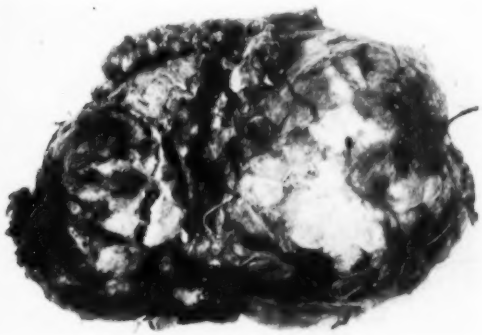

Fig. 8. Case 4. Encapsulated tumor which had broken through its capsule and was removed in three stages. Malignancy is graded 3.

at infrequent intervals he had had spells of unconsciousness. The urine and blood were normal. The Wassermann reaction was negative. Examination of the fundi disclosed bilateral choked disk of 3 diopters and left homonymous notching for colors in the upper quadrant. Roentgenograms of the head were negative. Neurological examination showed the presence of horizontal nystagmus and palsy of the right external rectus. A diagnosis was made of brain tumor of the right temporoparietal region and exploration was advised.

Through a right temporoparietal exploration, an endothelioma was located under the right temporal lobe pushing the occipital lobe toward the median line. The tumor was covered with animal membrane and the wound was closed. Ten days later a unilateral occipital flap was turned in conjunction with the previous flap and the tumor was found to arise from the right lateral sinus. It was definitely encapsulated and had not invaded or broken through the capsule, and was easily enucleated after resection of the lateral sinus and a portion of the tentorium cerebelli (Fig. 7). The tumor was active and cellular, with cells of varying size. The nuclei also varied in size but were deeply staining. Mitotic figures were seen throughout. Structurally the tumor did not adhere to form and the cells were undifferentiated. It was highly malignant (graded 3) and rapidly growing, and would soon have broken through the capsule and invaded the surrounding structure (Fig. 2).

Case 4. A man, aged 25, complained of dull throbbing headaches which had begun about 6 months previously. They occurred every week or 10 days, coming on in the early morning. He had also had transient attacks of diplopia.

The urine and blood were normal. The blood Wassermann reaction was negative. Vision was normal but acute bilateral choked disk of 3 diopters and right homonymous hemianopsia were noted. Roentgenograms of the head were negative. Neurological examination was negative except for slight aphasia and slight facial weakness on the right side. Because of the hemianopsia, facial weakness, and mild aphasia, a diagnosis was made of brain tumor in the left temporal area and exploration was advised.

A large osteoplastic flap was turned down over the left temporoparietal area revealing endothelioma at the juncture of the lateral and sigmoid sinuses. There was moderate bleeding, and since the tumor was large it was decided to remove it at a second stage. Ten days later a cerebellar flap was turned in conjunction with the temporoparietal flap. The tumor was very large and vascular, and about three-fourths of it was removed with electric cautery. Transfusion was given at this time, and the wound was packed and closed. Ten days later the wound was reopened and after the sigmoid and lateral sinuses had been ligated the remainder of the tumor was removed. The tumor (graded 3) was very cellular, the cells varying in size and in staining propensities, undifferentiated, and without systematic arrangement. Undoubtedly the tumor was malignant since it had broken through the capsule in several places (Fig. 8). The short history testifies to the rapid growth.

Case 5. A woman, aged 43, came for examination because of failing vision, weakness and headache. The headaches had begun about 3 years previously. They were confined to the occipital region and lasted from a minute to an hour. Gradually they became more severe and one year previously nausea, vomiting, and failing vision developed. Mental dullness, and numbness and tingling of the left leg were noted at about this time. This increased until the entire left side was markedly weakened and there was a Parkinson's tremor of the right hand.

The urine and blood were normal. The blood Wassermann reaction was negative. Vision in the right eye was 3/60 and in the left eye light perception. Fields showed concentric contraction and the fundi secondary optic atrophy. Roentgenograms

Fig. 9. Case 6. Encapsulated nodular tumor which was completely removed. It had not broken through its capsule but microscopically it is malignant (Fig. 4).

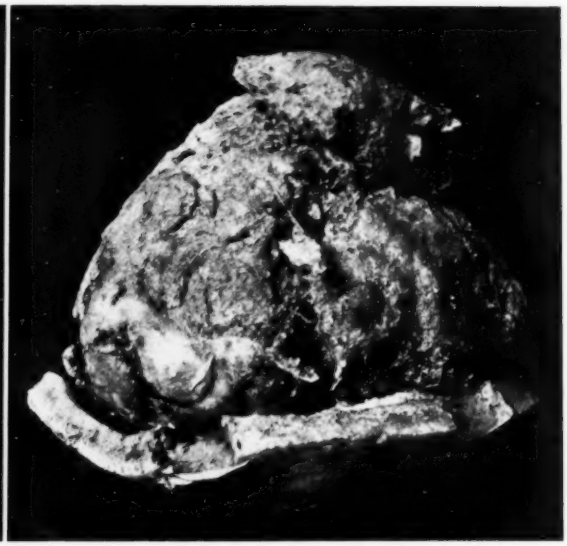

Fig. 10. Case 8. Encapsulated neoplasm which had invaded the overlying bone and broken through into the underlying brain. Malignancy is graded 2.

were negative. Neurological examination showed diminution in speed and strength of the levator scapuli muscle and diminution in speed and tonus of the gluteus maximus muscle on the right side; on the left side there was diminution in strength of the interossi muscles and the gluteus maximus muscle. The biceps reflex was increased on both sides, as were the supinator reflexes. Bilateral Hoffmann and Chaddock signs were present and the patellar and Achilles reflexes were increased. There was definite incoordination and the gait was slightly spastic on the left side. A diagnosis was made of parasagittal endothelioma and exploration advised.

The removal of the tumor was completed at a second stage operation 10 days after the first stage. The tumor arose from the longitudinal sinus with the greater portion on the right side but extending into the left; it was more or less encapsulated and rather soft. A large portion of the longitudinal sinus, as well as a portion of the falx cerebri, was included in the resection. The tumor had broken through the capsule and had invaded the brain in several areas. The microscopic picture was that of a fairly well differentiated cellular neoplasm (graded 2) with few mitotic figures (Fig. 3).

Case 6. A man, aged 57, came to the Clinic complaining of headache, dizzy spells, and loss of memory. The headaches had begun about a year previously and had been increasing in severity until 3 months prior to his visit, when he was awakened by them every morning.

Urine and blood were normal. The blood Wassermann reaction was negative. Vision was normal. Bilateral choked disks of 3 diopters were present and the fields showed concentric contraction for form and colors. Roentgenograms of the head were negative. Neurological examination disclosed some lack of co-operation and mental dullness with slight weakness of the left side. A diagnosis was made of brain tumor in the right frontal motor area, and exploration advised.

An osteoplastic flap was turned down over the right frontal motor area, revealing a tumor adherent to the dura, nearly opposite the middle and superior frontal convolutions, and pressing backward on the motor area. The tumor was encapsulated, densely adherent, and very vascular. It was removed after ligation of the longitudinal sinus at a second operation a week later. It measured 8 by 7 by 6 centimeters and weighed 155 grams (Fig. 9). The growth was very cellular and active. The cells conformed to an irregular structure and there was an attempt to form whorls. Only a few mitotic figures were seen. Malignancy was graded 1 (Fig. 4).

Case 7. A woman, aged 35, complained of dizziness and headache of 18 months' duration; at first they came on in the morning about once a week, but for 3 weeks they had occurred daily. The patient had become drowsy and stuporous, and the gait somewhat uncertain. A tumor in the left frontotemporal region had been present for about 6 years; it had increased in size very slowly but in the previous 3 weeks, after the birth of a child, it had grown decidedly larger.

A specimen of urine contained a few red blood cells and pus cells, and the blood urea was 16 milligrams.

The hæmoglobin was 72 per cent, the erythrocytes numbered 4,220,000, and the leucocytes 10,000. The blood Wassermann reaction was negative. The eyes were normal. Roentgenograms of the head showed a large osteoma in the left temporoparietal area. Neurological examination revealed a dull stuporous person with aphasia, incapable of co-operation. There was decided perseveration. A diagnosis was made of endothelioma, and exploration was advised.

At operation the osteoplastic flap, including the osteoma, was elevated with difficulty. The large endothelioma was infiltrating the brain and spreading out under the dura. The tumor was cellular; the cells varied in size but were undifferentiated. The nuclei also varied in size and staining propensities. Many mitotic figures were scattered throughout. Malignancy was graded 4 (Fig. 5).

CASE 8. A woman, aged 43, complained of headache of 10 years' duration, and of loss of memory and blurring vision for the previous 6 months. For 7 months she had noted numbness and tingling over the left arm and leg. She was nauseated and vomited at rare intervals during the intense headache.

Examination revealed slight exostosis over the right parietal area. Pus in the urine was graded 1 with 20 cells to the field. The blood urea was 30 milligrams. The blood was cytologically normal. The blood Wassermann reaction was negative. Roentgenogram of the head showed marked intracranial pressure. Vision was normal; there was concentric contraction for form and colors, and slight blurring of both disks. Neurological examination showed bilateral reduction of the reflexes of both lower extremities, slight inco-ordination, especially on the left side, ataxic gait, and bilateral positive Rhomberg sign. A diagnosis was made of brain tumor in the right parietal region and exploration was advised.

Exploratory craniotomy was performed on the right parietal area and a malignant endothelioma was found. The tumor was definitely encapsulated except in the posterior part where it had penetrated the capsule into the underlying brain. The bone was involved, and the tumor with the attached dura and bone was removed (Fig. 10). The tumor was very cellular (graded 2). The cells varied in size and did not conform to type structurally. A few mitotic figures could be seen throughout.

CASE 9. A woman, aged 55, complained of headache and vomiting associated with character change and loss of memory of 18 months' duration. The headaches were mainly in the right frontotemporal area.

The urine contained pus, graded 1, with 6 cells to the field. Leucocytes numbered 6,800. The blood and spinal fluid Wassermann reactions were negative. The fundi showed bilateral choked disks of 1 diopter. The neurological examination was negative except for diminution of speed in the left hand and positive Rossolimo and Mendel Bechterew signs on the left. A diagnosis was made of right frontomotor lesion and exploration advised.

An osteoplastic flap was turned down over the right frontoparietal region and a large encapsulated brain tumor attached to the dura was found extending mesially and anteriorly to the frontal lobe. The tumor appeared to be about 10 centimeters in diameter and was too large to remove without turning the flap forward. This was done 5 days later and the tumor was removed. The tumor was encapsulated but had broken through in several places. It was cellular; the cells were partially differentiated and many mitotic figures could be seen throughout. Malignancy was graded 3.

CASE 10. A man, aged 24, came for examination because of headache, general malaise, and left-sided paralysis. Two years previously he had been struck on the head, and 4 months previously he had noticed a lump over the right parietal area. The headaches had come on 3 weeks before his registration and occurred early each morning. One week after their onset he had noticed paralysis of the left hand and arm.

The urine and blood were normal. The blood Wassermann reaction and the roentgenograms of the head were negative. Examination of the fundi revealed bilateral choked disks of 3 diopters, with hæmorrhage and exudate. The ocular movements were slow, with poor elevation and questionable conjugate weakness to the left. Neurological examination showed decrease in strength and in speed of both left extremities. There was definite incoordination on the left side. A diagnosis was made of brain tumor of the right parietal region and exploration was advised.

A large osteoplastic flap was turned down over the right parietal area and an infiltrating tumor, evidently arising from the dura and eroding and invading the bone was revealed (Fig. 11). The tumor was about 9 centimeters in diameter and 5 centimeters thick, with numerous extensions along the dura. The entire bone flap and all of the dura of the exposed field were removed. As much of the tumor as presented was removed, it being necessary to resect part of the longitudinal sinus. However, there still remained a flat portion of the tumor around the edge of the dura and the brain underneath was flattened and slightly degenerated (Fig. 12). The endothelium was highly malignant (graded 4) and had involved the dura and bone. At necropsy multiple metastatic areas in the dura and implantations on the arachnoid were noted. This was a typical diffuse type of neoplasm *en placque*. The tumor was cellular with undifferentiated cells and mitotic figures throughout (Fig. 6).

CASE 11. A man, aged 52, complained of headache and vomiting which had persisted for 3 months. He also complained of having had diplopia and blurring vision for the previous 5 weeks. The headaches, which occurred in the morning, had been continuous for the previous 5 weeks.

The systolic blood pressure was 84 and the diastolic 66. The urine contained pus, graded 1, with 5 cells to the field. The blood urea was 44 milligrams for each 100 cubic centimeters. The hæmo-

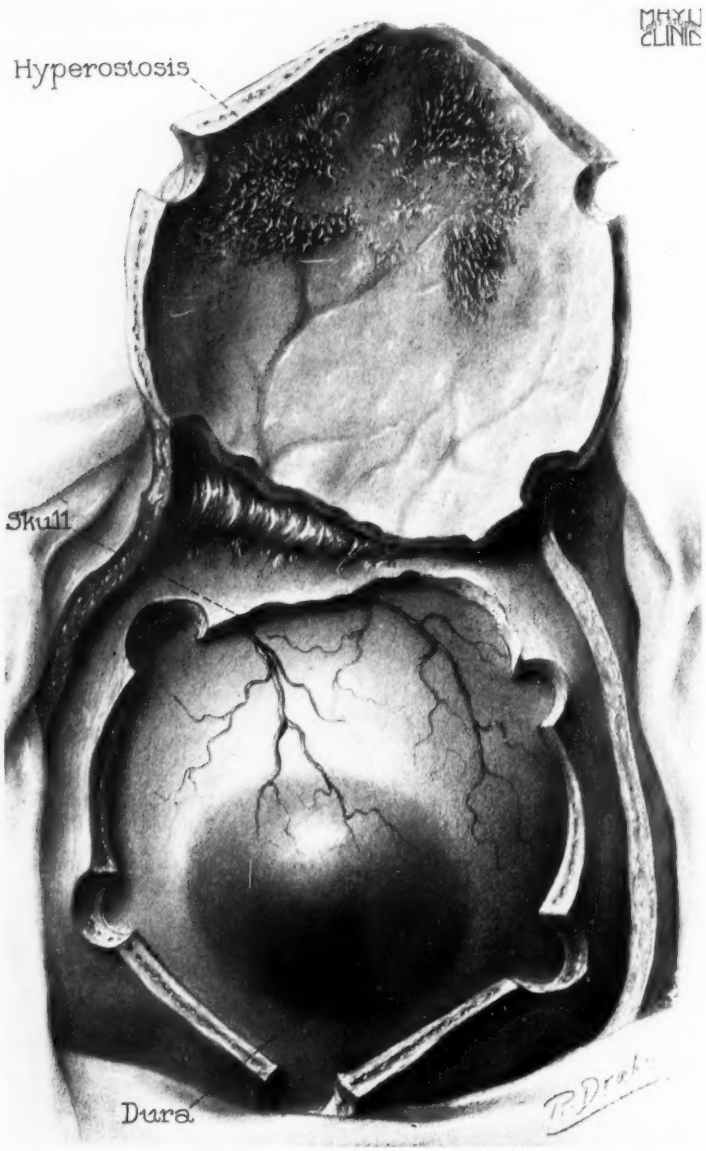

Fig. 11. Case 10. Malignant endothelioma as it appeared on elevating the bone flap.

globin was 85 per cent, the erythrocytes numbered 4,600,000, and the leucocytes 5,800. The blood Wassermann reaction was negative. The fundi showed a choked disk of 3 diopters on the left; the right was normal. The roentgenograms of the head were negative. Neurological examination showed horizontal nystagmus and adiadokokinesia, +3 on the left. There was tinnitus in the left ear and partial nerve deafness. A diagnosis was made of cerebellar tumor and exploration was advised.

Bilateral cerebellar exploration and decompression was performed and an encapsulated tumor of the left cerebellar fossa was found. The tumor was very vascular, and a second-stage operation was decided on. At operation 10 days later, when the tumor was enucleated it was found to arise primarily from the arachnoid and dura on the posterior inferior surface of the cerebellar lobe. It was encapsulated and had not broken through and invaded the surrounding brain tissue. The tumor (graded 3) was cellular and partially differentiated with mitotic figures scattered throughout.

A review of the histories of these cases, and a comparison of the microscopic appearance of the neoplasms, showed that in Cases 1, 3, 4, 10, and 11, the onset of symptoms occurred less than 6 months before the tumor became evident, and the degree of cellular activity was found to be correspondingly pronounced. In Cases 1, 4, and 10, the tumor had broken through the capsule and invaded the underlying brain. Although the tumors in Cases 3 and 11 were completely surrounded with their capsules, yet early removal (6 weeks, and 3 months, respectively, after the onset of symptoms) would account for the evident discrepancy.

In Cases 2, 5, 6, 7, 8, and 9, the patients gave a history of having had symptoms for from 1 to 3 years, and yet if the time element is carefully analyzed, it is apparent that the severity of the symptoms increased shortly before the patients' registration. This is most clearly shown in Case 7, in which symptoms had begun with headaches 18 months previously. The patient had a large osteoma which she thought had existed for 6 years. Following the birth of her baby 3 weeks before admission, the osteoma increased in size and the intracranial symptoms became more severe. This is in accord with the conception of the influence of pregnancy on neoplasms elsewhere in the body. With regard to the cellular activity as seen microscopically, the malignancy in this group as a whole was not as severe as in the first group. In fact comparison seemed to show that the neoplasms that had existed longer were originally benign and that a malignant change had caused increased severity of the symptoms. This is evidenced by areas throughout the tumor which approach the benign in structure with the characteristic whorls and psammomata.

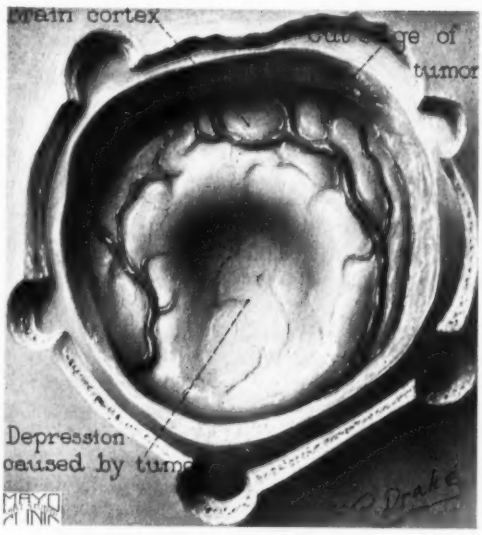

Fig. 12. Case 10. Malignant endothelioma *en placque* showing the cut edge of the tumor and the depression of the cortex.

Broders grades malignant epitheliomatous neoplasms on the cytological picture of the relative differentiation of the cells. He has observed that epitheliomata that have produced the so-called epithelial pearls are of a low degree of malignancy. In other words, the tumors of low malignancy show a greater degree of differentiation and tend to form whorl-like areas of keratinized epithelium. The more malignant types of the neoplasm do not tend to develop such whorls. Since these dural endotheliomata arise from the ectodermal layer and show characteristics similar to the epitheliomata, why is it not plausible to apply to them the same method of grading?

A review of the 56 cases of intracranial endotheliomata in this series demonstrates that the tumors present a definite structure under the microscope, characterized by whorls of long, flat cells with small nuclei and the formation of psammoma bodies. This is true only of the benign or inactive tumors; when these are compared with the 11 malignant neoplasms a marked difference in the cytological picture can be seen.

In these malignant types of endothelioma, a psammoma body is rarely seen and then it is

associated with marked differentiation of the cells and absence of mitosis, which stamps the malignancy as of low grade. Also when the whorl-like structure is seen the differentiation of the cells is fairly complete and it is difficult to find the mitotic figures. The malignancy of these neoplasms is also of a low grade. However, in the more malignant types the cells are but slightly differentiated, without structural formation, and with many mitotic figures. Consequently, the 11 malignant endotheliomata recorded here have been graded according to Broders' classification of epitheliomata. After gradation of the tumors with regard to cellular differentiation, mitosis, and structure, the histories were reviewed in order to see if the comparison also followed Broders' classification. It was found that the tumors that presented the highest degree of malignancy microscopically (grades 3 and 4) were rapid in onset and short in duration; and that those with a higher degree of differentiation, fewer mitotic figures, and more regularity of structure (grades 1 and 2) had existed longer and were insidious in onset.

CONCLUSIONS

1. Intracranial endotheliomata are not always benign. A small percentage are malignant and the relative malignancy is judged by the amount of cellular differentiation and mitosis, and the tendency of the cells to arrange themselves in regular formation. The malignancy is graded from 1 to 4.

2. Tumors graded 1 are the least malignant and are characterized by more complete differentiation of the cells, fewer mitotic figures, and more distinct tendency to form whorls and psammoma bodies. In tumors graded 2 and 3 the microscopic picture becomes more cellular and less regular as regards structure, and mitosis is more common. The most malignant tumor (graded 4) is not regular structurally, the cells being undifferentiated, and mitotic figures being scattered throughout.

3. From the surgical standpoint, these malignant endotheliomata, if they have not invaded surrounding structures, are comparable to such malignant tumors elsewhere in the body, and if they are completely removed a definite cure is effected. However, if they have broken through their capsule and have invaded the surrounding tissues, the grade of malignancy indicates the likelihood of recurrence, and if they are incompletely removed the grade of malignancy indicates the time element involved in this recurrence. Furthermore, the endotheliomata of short duration with rapid progression of symptoms indicate early and complete removal since in all probability they will prove microscopically malignant in grades 3 or 4.

BIBLIOGRAPHY

1. Bailey, Percival, and Cushing, Harvey. Tumors of the Glioma Group. Philadelphia: J. B. Lippincott Company, 1925, 175 pp.
2. Broders, A. C. Squamous-cell epithelioma of skin. A study of 256 cases. Ann. Surg., 1921, lxxiii, 141–160.
3. Cushing, Harvey. The cranial hyperostoses produced by meningeal endotheliomas. Arch. Neurol. & Psychiat., 1922, viii, 139–154.
4. Idem. The meningiomas (dural endotheliomas): their source, and favored seats of origin. Brain, 1922, xlv, 282–316.
5. Harvey and Burr. Quoted by Learmonth.
6. Learmonth, J. R. On leptomeningiomas (endotheliomas) of the spinal cord. Brit. J. Surg., 1927, xiv, 397–471.
7. MacCarty, W. C. A biological conception of neoplasia, its terminology and clinical significance. Am. J. M. Sc., 1919, clxii, 657–674.
8. Mallory, F. B. The type cell of the so-called dural endothelioma. J. Med. Research, 1920, xli, 349–364.
9. Oberling, C. 1922. Quoted by Roussy and Cornil.
10. Penfield, W. G. Osteogenetic dural endothelioma: true nature of hemicraniosis. J. Neurol. & Psychopath., 1923–1924, iv, 27–34.
11. Phemister, D. B. The nature of cranial hyperostosis overlying endothelioma of the meninges. Arch. Surg., 1923, vi, 554–572.
12. Roussy, Gustave, and Cornil, Lucien. Les tumeurs méningées. Ann. d'anat. pathol. méd. chir., 1925, ii, 63–79.

THE PREVENTION OF PERITONEAL ADHESIONS AND ENCAPSULATION

Preliminary Report of an Experimental Study of Peritoneal Reaction to Hypertonic Dextrose Solution[1]

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IN the voluminous literature that has originated in the experimental and clinical study of the peritoneum, two basic facts have received universal acceptance.

1. No foreign body, whether fluid or solid, however bland or non-irritating or sterile can be placed in contact with the peritoneum without producing prompt partial or complete encapsulation by adjacent loops of bowel and omentum.

2. No method has been developed whereby adhesions between contiguous inflamed loops of bowel and omentum can be prevented.

Yates (5) is largely responsible for the present day attitude on the subject of peritoneal drainage. His conclusions may be quoted to advantage herewith:

1. Relative encapsulation of the drain is immediate.

2. Absolute encapsulation occurs in less than 6 hours; this can be retarded but not prevented.

3. Adhesions under approximately normal conditions form about any foreign body.

4. Their extent and density depend upon the degree and duration of the irritation of this body.

5. Primarily fibrinous, these adhesions become organized in a few days (3 days in dogs).

6. Irrigation through the drain is futile to prevent adhesions and dangerous.

7. Peritonitis, if not too severe, possibly aids in the rapidity of the encapsulation of the drain.

Since 1905, a vast amount of experimental effort has been expended in the attempt to find a substance that would prevent adhesions, or a drain that would defy this inevitable encapsulation. Petrolatum, the various paraffine oils, olive oil, egg albumin, milk, peptonized milk, Ringer's solution, ammonium oxalate, sodium citrate, all have failed to accomplish this end. Such bland substances as the oils not only fail to prevent fibrin formation, but actually produce adhesions of a density not commonly seen after a bacterial peritonitis.

Adhesions and encapsulation begin with the precipitation of fibrin on the peritoneal surface. The amount of fibrin varies within wide limits in the presence of inflammation, occasionally being entirely absent in cases of virulent, rapidly spreading peritonitis. Under approximately identical conditions, there is an individual variation in the amount of fibrin formation that cannot be explained. We have noted this variation in our experimental animals. In the presence, however, of a serous transudate of massive proportions, under the identical degrees of irritation produced by rubber drains and tincture of iodine solution, we have been able to prevent fibrin formation with the accompanying encapsulation and adhesions over a period ranging up to 72 hours. We used a 20 per cent dextrose solution to produce such a transudate.

When a hypertonic solution is placed in contact with the peritoneum, the resultant osmotic tension promptly produces a transudate proportional to the amount and strength of the solution. A considerable amount of experimental work has been devoted to the use of sodium chloride in peritonitis. Very little has been done with dextrose. Kuhn (2) in 1911 first suggested the substitution of sugar solution for salt solution in the treatment of this disease. He also called attention to the fibrinolytic action of sugar and suggested the possibility thereby of improving drainage. He did not, however, carry out his idea in any experimental work with drains. Reschke (4) 10 years later, finding little work checking up that of Kuhn, studied the effect of hypertonic solutions on peritoneal resorption with a view

[1] Read before the Chicago Surgical Society, May 6, 1927.

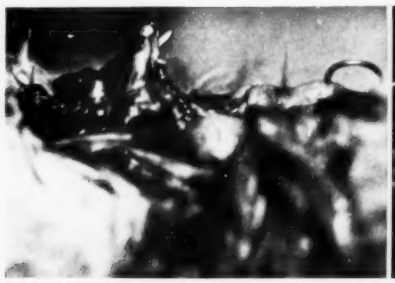

Fig. 1 (left). Control experiment illustrating the typical reaction of the normal peritoneum to a sterile foreign body. The rubber tube is completely encapsulated (24 hours).

Fig. 2. Complete absence of fibrin and freedom from encapsulation at end of 24 hours resulting from use of hypertonic dextrose solution. This tube extended from the upper abdomen to the pelvis.

to using such solutions in peritonitis. Reschke could not verify the fibrinolytic action suggested by Kuhn, but concluded that the chief value in the use of dextrose was in the delay in resorption of the exudate in peritonitis.

EXPERIMENTAL WORK

The first phase of the work consisted in the study of the reaction of the peritoneum to rubber drains in the presence of dextrose solution; the concentration of the latter was 20 per cent. Two types of tubing were used; a soft tubing of the consistency of dental dam, and ordinary soft red and black tubing with a diameter of 5 millimeters. The tubing was introduced through a short rectus incision, the entire tubing being in the peritoneum, none of it being allowed to project. In our earlier experiments the tube was allowed to project through the abdominal wall in the usual manner of abdominal drainage, but this had to be abandoned because in a dog a water tight juncture cannot be made and even with the tube tightly clamped, leakage along the side of the tube occurred.

Immediately following closure of the abdomen, dextrose solution was injected hypodermically just below the right costal border. In one hour the volume of fluid is almost doubled. Narat (3) studying the action of dextrose in rabbits found that 50 cubic centimeters of solution gave a transudate of 140 cubic centimeters in 2½ hours, and in 24 hours the abdomen was again free of fluid. We found that when only a single injection representing the maximum safe dosage was given, the abdomen was fluid-free at the end of 24 hours. As we had in mind the possibility of preventing encapsulation and of maintaining the patency of the drain over a period of at least 2 days, injections were made into the abdomen of the animals at periods ranging from 10 to 12 hours. In a 20 pound dog, 175 to 200 cubic centimeters (35 grams to 40 grams dextrose) of solution was injected. If the animal was operated on between 2 and 3 p.m., a second injection was given at 11 p.m. Only 100 to 125 cubic centimeters were given at the second injection. The intervals elapsing between the first two or three injections must not be more than 12 hours because of the rapidity with which the transudate is absorbed particularly during the first 24 hours. The presence of fluid in the dog's abdomen is readily detected by palpation, and we used this as a guide in determining the amount of solution to use at subsequent injections. After the first 24 hours the rapidity of absorption of the transudate seemed materially lessened; the amount of solution necessary to maintain the transudate could then be reduced approximately 25 per cent.

Autopsies were done at intervals of 1, 2, and 3 days. As far as we were able to determine, a dog of a given weight, under identical conditions and getting the same amount of dextrose at each injection, had no more transudate at the end of the third day than at the end of the first. A dog weighing 25 pounds who had been given five injections amounting to 800 cubic centimeters over a period of 2 days had as a rule from 400 to 500 cubic centimeters of tran-

Fig. 3.

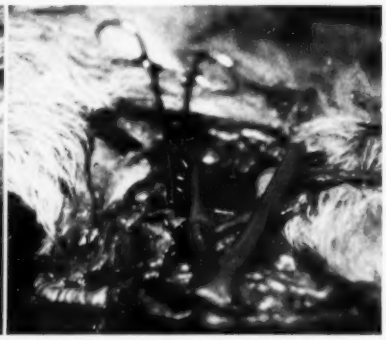

Fig. 4.

Fig. 5.

Fig. 3. No encapsulation at the end of 48 hours.

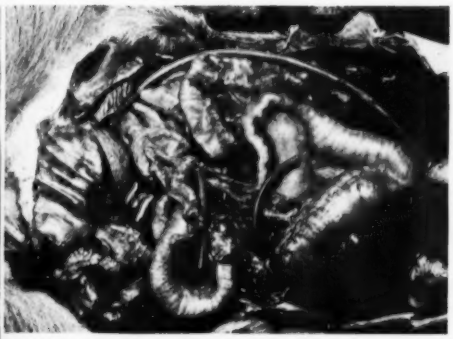

Fig. 6.

Fig. 4. A tiny strand of fibrin after 28 hours serves to emphasize the absence of encapsulation.

Fig. 5. Partial failure. When volume of transudate is insufficient, plugging of drain openings by omentum occurs.

Fig. 6. Multiple drains remain unencapsulated, save, in this instance, for slight fixation of omentum to lower left tube.

sudate. The largest transudate obtained was 1300 cubic centimeters in a 44 pound dog. When the volume ran below 300 cubic centimeters in a 20 pound dog at the end of 24 hours, there was usually a partial encapsulation of the drain. Several times, however, the volume ran below the above figure, and there was no encapsulation, indicative probably of a normal variation in the fibrin-forming capacity of different animals.

The transudate was typically serous, and almost always faintly blood tinged. The peritoneum retained its normal luster, and was free from other change except for the presence of fine ecchymoses. There was no gross hæmorrhage even in animals which died from dehydration. The peritoneal pathology could be described as a mild serous peritonitis. The most striking findings, however, were:

First, the complete or, where partial failure was recorded, the almost complete absence of fibrin. When fibrin was present, either an insufficient transudate had been produced, or leakage around the drain had occurred. It was possible to eliminate fibrin to the finest strand.

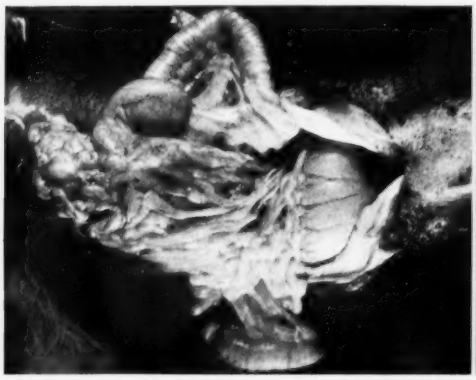

Fig. 7 (left). Twenty-four hours following the application of tincture of iodine to about 16 inches of small bowel. Almost all of the small bowel and omentum agglutinated into one solid mass forming a tumor readily palpable through the abdominal wall.

Fig. 8. "Iodine peritonitis" which has been treated with hypertonic dextrose solution for 24 hours. The inflamed loop is seen to the left. There is very little fibrin. There are no adhesions, and the omentum to the right is free from infiltration.

Second, rubber drains in the presence of this transudate remained entirely unencapsulated not only by the bowel, but also by the omentum. The latter structure is far more active in the process of encapsulation than the bowel, and when a result classified as a partial failure was obtained, the omentum was invariably found wrapped about one end of the tube.

Third, when fibrin formation was prevented, the omentum remained entirely free from infiltration, a fact of interest because migration of the omentum toward a foreign body is always associated with an obvious gross infiltration, assumed by some observers to be the mechanism responsible for such migration. In its migration toward a drain the omentum has an uncanny affinity for the open end of the drain which it promptly plugs, even though the remainder of the drain be entirely free. When the end of a drain becomes plugged by omentum, mere contact between this infiltrated portion of omentum and hypertonic solution will not restore the patency of the drain. In two of our earlier animals, dextrose was introduced after encapsulation had been present for 8 hours. After 48 and 72 hours both drains were almost completely encapsulated.

In a second series of experiments, tincture of iodine was used to produce a chemical peritonitis with subsequent adhesions between contiguous loops of bowel and omentum. The iodine was painted on the small bowel and at once rubbed off with dry gauze, somewhat abraiding the serosa. This promptly produces a violent reaction in the bowel, visible in a few minutes. Within 24 hours this unfailingly produces a tumefaction palpable through the abdominal wall, consisting of bowel several times the amount so treated and omentum, agglutinated into one solid mass. In nine animals so treated, dextrose solution was injected after closure of the abdominal wound. An interval of 20 to 30 minutes following the application of the iodine was allowed to elapse before the dextrose came into contact with the bowel. Excepting for two deaths, one from iodine poisoning and one from dehydration, agglutination between contiguous inflamed loops and omentum was prevented, although here and there a strand of fibrin was present. This constitutes a much more severe test of the action of dextrose than that of a sterile drain because of the greater degree of inflammatory reaction present. It cannot be argued that the presence of the dextrose a short time later washes off the iodine and so prevents inflammation, because at autopsy a day or two later the brittle infiltration of the involved loops and hæmorrhages in the mesentery are proof of the damage inflicted.

DISCUSSION

Two questions remain to be answered: (1) what are the possibilities for harm, and (2), what clinical application has this work?

The greatest danger, in fact the only serious one, is that of dehydration. In a total of 56 animals there were 5 deaths from this cause, the earliest death being 8 hours after the first injection; the latest at 46 hours; 2 died in the vicinity of 24 hours. In all 5, the maximum safe dose had been far exceeded.

Reschke ascribed the danger as being essentially due to extensive dehydration of red cells. An irreparable injury done by this process can easily be recognized according to Hamburger (1) by the extravasation of coloring matter from the red cells. The resistance of the red corpuscles to dehydration has a certain range of variation, but if exceeded, hæmolysis occurs. Kuhn found that 50 per cent solutions of grape sugar amounting to from one-thirtieth to one-twentieth of the body weight caused the death of the animal in a short time, but that a solution representing one-fiftieth of the body weight in such concentration was readily tolerated. Kuhn, however, did not carry his animals over repeated injections. The latter dose (one-fiftieth) is materially in excess if repeated at 12 hour intervals, for nausea develops in dehydration and the animals will not drink. On the other hand we have carried a control animal for 5 days with his abdomen full of fluid with no obvious disability or impairment to health, and on an amount of solution running from 30 per cent to 40 per cent below the safe limit.

We did not routinely inject saline solution, as did Reschke in his studies on the cryoscopy of the blood and transudate. Repeated injections of normal salt solution would undoubtedly raise the limit of safety, both as to the amount of solution injected, and the number of injections given, and is a procedure that is easily followed in the human. Kuhn demonstrated experimentally that with simultaneous subcutaneous injections of normal salt solution, larger doses of sugar solution of the same concentration will be tolerated intraperitoneally.

Local damage to the peritoneum may be disregarded; microscopically only a serous peritonitis is produced. The inflammatory reaction in the omentum to a sterile foreign body is far in excess of the changes produced in that structure by dextrose.

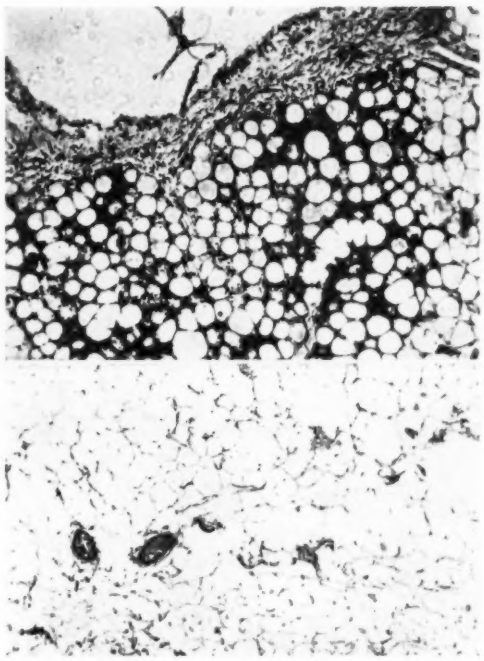

Fig. 9 (above). Omentum showing infiltration the equivalent of a moderate grade of peritonitis, resulting from contact with a sterile drain. ×65.

Fig. 10. The microscopic as well as the gross appearance of the omentum remains almost unchanged in the presence of a drain, when dextrose solution is used.

The question of taxation of sugar tolerance is not one of moment. Animals injected over a period of 48 hours almost invariably had a glycosuria and a marked hyperglycæmia. The use of insulin may occasionally be desirable. On the other hand the rapid excretion of the sugar was obvious from the rapidity with which it disappeared from the transudate. Within 6 hours after an injection ranging from 150 to 200 cubic centimeters or more, depending upon the weight of the animal, it was a common observation that the transudate contained no dextrose or only a trace.

As to the clinical application of the results of this study, our work is manifestly incomplete, in that it does not include studies of

peritoneal absorption in the presence of dextrose and the possibilities for prolonged drainage in bacterial peritonitis. Our studies so far demonstrate that in animals, hypertonic dextrose solution will prevent fibrin formation in the presence of a sterile peritonitis of moderate grade. If further study leads to the conclusion that the same conditions hold true for bacterial peritonitis, then such a procedure as has been detailed will have a field of usefulness in cases of severe diffuse peritonitis.

CONCLUSIONS

1. Hypertonic dextrose solution injected intraperitoneally produces a transudate.

2. If the amount of such transudate is sufficient, fibrin formation can be prevented.

3. By this means the patency of a drain within the peritoneum can be maintained for several days.

4. In a similar manner adhesions between inflamed loops of bowel can be prevented.

5. The method opens up possibilities in the prolonged drainage of the peritoneum in cases of diffuse peritonitis.

6. It is devoid of danger if dehydration is prevented.

The writer wishes to acknowledge the valuable assistance in the experimental work of L. W. Christian, G. C. Foster, and P. W. Butz.

BIBLIOGRAPHY

1. Hamburger. Osmotischer Druck und Ionenlehre.
2. Kuhn, F. Arch. f. klin. Chir., 1911, xcvi, 759.
3. Narat, Joseph K. Ann. Surg., 1923, lxxiii, 357.
4. Reschke. Arch. f. klin. Chir., 1921, cvi, 466.
5. Yates, John L. Surg., Gynec. & Obst., 1905, i, 473.

AN UNUSUAL FATAL OPERATIVE WOUND INFECTION YIELDING A PATHOGENIC ANAEROBE OF THE GAS GANGRENE GROUP NOT HITHERTO DESCRIBED

With Direct Reference to Catgut as a Source

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GAS gangrene in its clinical manifestations came into the experience of a host of surgeons during the World War. But the majority of army surgeons and bacteriologists had no very clear conception of the etiology of the disease. It was generally believed that "gas gangrene" was caused by the "gas bacillus," and this signified to most minds the Welch bacillus, bacillus aerogenes capsulatus (10).

It was, of course, no newly recognized infection. The process had been described under a multitude of names by a multitude of surgeons of the older generation, each one apparently attaching to it a name depicting that particular clinical feature with which he was most impressed; for example, "traumatic gangrene," "gangrenous phlegmon," "putrid emphysema," "bronzed erysipelas," "malignant œdema," etc., etc.

It was early recognized that anaerobic organisms were chiefly concerned in the infection but the inherent technical difficulties in obtaining and maintaining pure cultures of these organisms, the inadequate differential methods and descriptions, as well as the chaotic conditions of the taxonomy, led to great confusion and controversy. On the one hand, different organisms or mixtures of organisms were called by the same name because they were derived from clinically similar cases and on the other hand, the same organism was often given different names when isolated from cases judged clinically different.

During the war, the large number of cases occurring among the wounded soldiers, rendered imperative a re-study of the whole matter from a modern point of view but, in the temporary war hospitals, the facilities were not available for making careful analyses of the anaerobic flora of infected wounds. In the great majority of cases, the wounds were contaminated with mixtures of organisms, both aerobic and anaerobic. When cultures were made from such wounds, the very pressure of time made identification of species next to impossible. In some of the larger hospitals and hospital center laboratories, where there were bacteriologists equipped for careful anaerobic studies, it soon became evident to all workers in that field, that the clinical disease called "gas gangrene" was not a biological entity. Bacillus aerogenes capsulatus was frequently found to be missing from the wounds, and other organisms were present in its stead.

But the anaerobic methods in use at that time made the isolation of pure cultures so difficult that the literature during and immediately after the war became filled with erroneous data on the cultural characteristics of the gas gangrene organisms. Gradually, however, technical methods improved and now, owing especially to the efforts of Weinberg and Seguin (9), Sacquepee (8), McIntosh and Fildes (5), Henry (4), Bulloch (2), Robertson (7), Bull and Pritchett (1), Hall (3), and many others, our knowledge of the bacteriology of gas gangrene, slight as it still is, has become more nearly commensurate with that of our ordinary aerobic wound infections.

It is now generally recognized that gas gangrene is not a specific infection (as, for instance, is erysipelas, caused always by the hæmolytic streptococcus), and that there is no specific "gas bacillus" responsible for all cases; that the infection is commonly, but by no means always, a mixed one; and that several varieties of sporebearing organisms (called generically clostridia in the recently adopted nomenclature) can, with care, be isolated in the great majority of traumatic cases as they

Fig. 1 (left). Section from abdominal wall lesion. *A*, Surface exudate containing colonies of cocci and bacteria; *B*, subcutaneous fat with cellular and fluid infiltration, architecture well preserved; *C*, aponeurosis; *D*, muscle with cellular and fluid infiltration. Fibers widely separated.

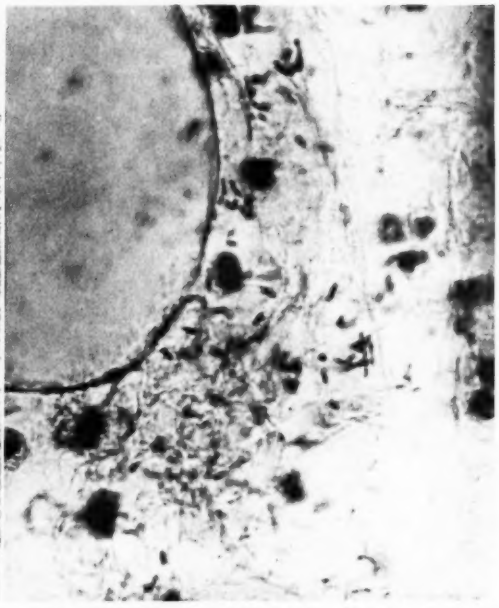

Fig. 2. Section from abdominal wall lesion of patient. Large Gram-positive spore-forming bacilli in the connective tissue of the subcutaneous fat. Architecture well preserved. (Oil immersion lens, ×1000.)

commonly occur. It is further recognized that these clostridia are naturally saprophytic inhabitants of the intestinal canal of man and domestic animals and of the soil contaminated by their excreta; that they are only rarely conveyed from one wound to another in the form of a contagium and that practically all such wounds become infected by dirt or other material more or less immediately contaminated by soil or intestinal contents.

But among the multitude of anaerobic organisms obtained by various workers from cases of gas gangrene, only a few species of those described have consistently met the requirements necessary to establish them as direct causative agents of the condition. The great majority of the varieties isolated have, in pure culture, either proved entirely innocuous to experimental animals, or else have become so, after one or two generations of transplants, although some of these may have enhanced the severity of an infection by their presence in a mixed flora.

Three or four separate species, however, have consistently maintained their virulence over prolonged periods of time and, when inoculated intramuscularly into laboratory animals, are regularly able to produce more or less accurately the lesions of gas gangrene. These are:

1. Clostridium welchii (bacillus aerogenes capsulatus, discovered by Welch in 1892. Bacillus perfringens of Veillon and Zuber. Bacillus phlegmonis emphysematosae of E. Fraenkel.)

2. Clostridium œdematis maligni. (Vibrion septique, first described by Pasteur in 1877. Bacillus œdematis maligni of Koch. Bacillus of Ghon and Sachs I.)

3. Clostridium novyi. (Bacillus œdematis maligni II, discovered by Novy in 1894 and rediscovered by Weinberg and by Sacquepee almost simultaneously and named by them respectively bacillus œdematiens and bacillus bellonensis.)

To these three may perhaps be added clostridium histolyticum (bacillus histolyticus, first described by Weinberg in 1917). This organism does not produce the toxæmia so characteristic of the disease under discussion, although it is able to cause extreme local destruction and digestion of the living tissue when

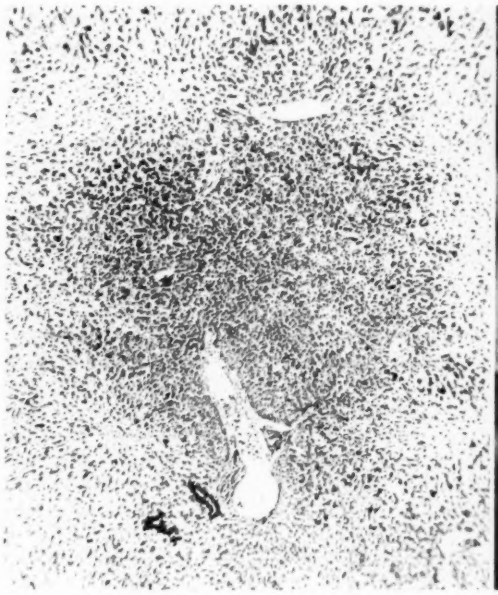

Fig. 3 (left). Section from the patient's liver. Extensive destruction of the liver tissue somewhat more marked around the central veins than around the portal areas.

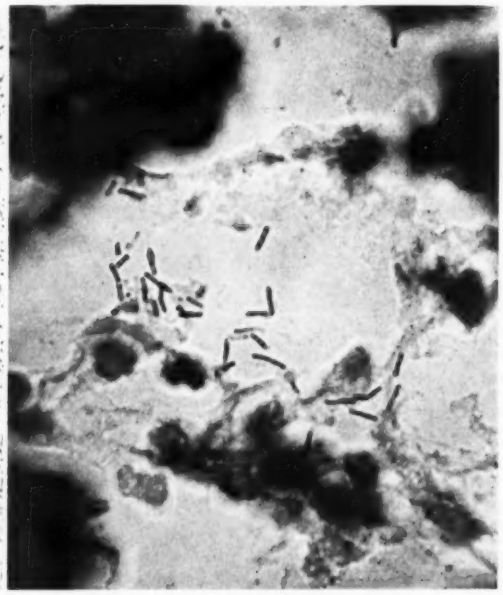

Fig. 4. Section from the patient's liver. Large gram-positive spore-forming bacilli scattered diffusely through the tissue. (Oil immersion lens, ×1000.)

injected in sufficiently large amounts into guinea pigs.

Each of the series mentioned is an entirely distinct species comprising strains which may vary in minor cultural features, in their agglutinins and in the degree of their pathogenicity but which possess in common certain fundamental characteristics rendering their differentiation from the other species not a particularly difficult matter. Moreover, each species produces a greater or less amount of highly specific exotoxin *in vitro* for which a specific antitoxin may be prepared. This fact is of the utmost importance in the final identification of any particular culture of a pathogenic anaerobe. For while, on the one hand, the antitoxin prepared from one strain of any given species is equally effective against any other cultural or agglutinative variant of the same species, on the other hand, it is never effective against the toxin of any strain of any of the other species.

One or other of these three species, with rare exception, has been regularly isolated from all cases of fatal human gas gangrene. Therefore, it is not without interest that we have obtained, from a fatal case, a clostridium which does not culturally agree with any of the others, which produces a true exotoxin not neutralizable by the antitoxins for any of the others and whose specific antitoxin is ineffective against any of their toxins.

It is of additional interest that we have been able to trace the source of the infection to the introduction into an operative wound of material contaminated with animal intestinal contents, that is, to surgical catgut which was not sufficiently "sterilized." Catgut, as is well known, is manufactured from the muscularis mucosæ of the intestine of sheep.

The purpose of this paper is to present the results of certain observations on this organism. We wish to report its characteristics in some detail and to discuss briefly its general significance.

First we will present the clinical aspects of the case from which the organism was taken.

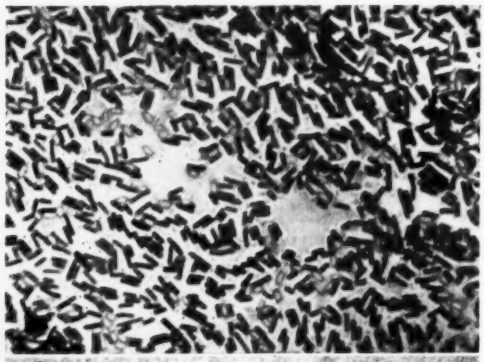

Fig. 5 (above). Clostridium œdematoides in a smear from a blood agar plate. Twenty hours' growth. Large gram-positive spore-forming bacillus, with spores paracentral when in the bacilli but most of them free. (×1000.)

Fig. 6. Colony of clostridium œdematoides on a blood agar plate. Twenty hours' growth. The colony is usually stellate with the long diameter in the direction of the streak of the inoculating needle. (×35.)

CASE HISTORY

The patient was a middle aged woman, in good general condition, suffering from fibrosis uteri with profuse uterine bleeding. She was cared for in another hospital by one of us (L. C.). A supravaginal hysterectomy was performed through a median hypogastric incision. The appendix was also removed, the stump ligated with plain catgut, carbolized and not inverted. Plain catgut was used for the pelvic sutures. The peritoneum was closed with continuous plain catgut. The fascia was sutured with chromic catgut and the skin with silk.

The course during the first week following the operation was without incident, save for the fact that the temperature curve was slightly higher than usual. On the first and second days it reached 101.8 degrees F. On the third day it was 101.2 degrees F. On the fourth, fifth, and sixth days it reached 100.4 degrees F. and on the seventh day fell to 100 degrees F. During this period the pulse ranged between 90 and 115, and on the seventh day it was 92. The skin sutures were removed on the sixth day, and there was apparently primary union, but the wound edges were slightly œdematous. On the eighth day the temperature rose again to 102 degrees F., and there was severe pain in the back. Herpes of the right buttock was noted. There was considerable pain in the region of the wound. These symptoms and signs increased during the next 24 hours. On the ninth day the external genitalia became very œdematous without apparent cause, and the temperature reached 102.2 degrees F. When the wound was dressed on the tenth day, it was found that there was a diffuse cellulitis of the abdominal wall below the umbilicus. Redness, pitting œdema of the skin and tenderness over the inflamed area increased during the next day. On the fourteenth day, 4 days after the appearance of the brawny induration, it was deemed wise to incise a softened area over the lower right rectus muscle. No free pus was found, but a profuse serosanguineous exudate filled the incision. The abdominal fat was firm and white, resembling bacon fat. There was practically no bleeding. Routine aerobic cultures at the time of this operation yielded no organisms. Following the operation there was some relief from pain but the indurated area gradually extended laterally and profuse serous discharge soaked the dressings. Aerobic and anaerobic cultures from the wound surface, on the day after the operation, were negative. An aerobic blood culture failed to show any growth.

On the fifteenth day after operation, Dr. Albert A. Berg saw the patient in consultation and called the condition "woody phlegmon." He advised the application of hot flaxseed poultices and gave a good prognosis. Thereafter the patient's temperature rose daily to 102.4 degrees F. and 102.6 degrees F. The pulse ranged from 90 to 140 and it was of poor quality. There was very little tendency to the formation of granulations in the wound. Her general condition, however, remained fairly satisfactory. The urinary output was good.

On the nineteenth day after the operation, the lower left rectus region was incised down to the posterior rectus sheath. The findings were the same as on the right side. The fat showed occasional necrotic foci and the muscle was very œdematous. Cultures of the fluid and a tiny bit of fat were taken by another bacteriologist. Again, no organisms were obtained by aerobic and anaerobic methods. There was little if any improvement following the last operation.

On the twentieth day the patient was seen by Dr. Joseph A. Blake who considered the condition to be a diffuse phlegmon in which pus might eventually form. He believed the incisions and the poulticing to be beneficial. His prognosis was favorable. On the twenty-first day the patient began to fail. Her pulse became weaker and more rapid. She became drowsy and was irritable when aroused. Five days later the original median wound began to break down and it was opened with scissors without an

anæsthetic. No frank granulations could be seen. Discharge of the same character as noted in the other wounds exuded from the wound surfaces.

On the twenty-seventh day, one of us (F. L. M.) was asked to see the case. The possibility of a clostridium novyi (bacillus œdematiens) infection was discussed. Cultures were taken *from the surfaces* of all three wounds. Hæmolytic staphylococcus aureus, non-hæmolytic streptococcus and bacillus subtilis were obtained. No anaerobic organisms were found.

A transfusion was followed by temporary improvement in the patient's general condition for 4 days, although the temperature during this period reached 103.8 degrees F. Subsequently the temperature rose to 104.4 degrees F. Then the patient became very much more restless and irritable, with cold perspiration, nausea, and vomiting. There was progressive weakness of the pulse.

On the thirty-fourth day, 50 mils of clostridium novyi (bacillus œdematiens) serum were given intramuscularly in the abdominal wall and thigh. There was no evidence of improvement. She became more drowsy and the pulse gradually mounted and weakened. Dr. Howard Lilienthal was called in at this time. He said that he had never seen a condition like it before. He believed it to be an infection in spite of the negative cultures from the tissues. He advised, as a last resort, excision of the involved subcutaneous tissue, leaving the skin intact. He favored loose packing of the wound and recommended transfusion both before and after the operation. A transfusion, given at this stage, was followed by a chill and fever reaching 106 degrees F. The pulse became imperceptible and she expired, conscious almost to the end.

An autopsy was performed about 10 hours after death. The three longitudinal wounds in the lower part of the abdomen were covered with thick purulent exudate. The lower half of the abdominal wall was twice its normal thickness and it had a board-like consistency. No crepitation was felt. All of the layers including the peritoneum were indurated and œdematous. The larger subcutaneous vessels were thrombosed. There were small ecchymotic areas in the involved tissues, but no free pus. When the peritoneal cavity was opened about 250 mils of amber colored fluid were found as well as some flakes of fibrin on the coils of the small intestine. The appendix stump was smooth. There was no thrombosis of the vessels of the abdominal cavity. The liver and spleen were congested. The kidneys showed nothing remarkable. About 50 mils of amber colored fluid were found in the pericardial sac. There were adhesions between the parietal and visceral pleuræ on the right, and both lungs were œdematous.

The microscopic examination of the lesion in the patient showed an extensive œdema of the subcutaneous fat and muscle, and a dense infiltration with mononuclear and polynuclear wandering cells. There was surprisingly little destruction of the fatty tissue, but the muscle fibers appeared to be atrophied as if by pressure (Fig. 1). The oil immersion lens revealed gram-positive rods in great numbers through the fat. These were distributed irregularly. In some places they were very dense and in others absent or very sparse (Fig. 2). The liver showed extensive diffuse degeneration which was chiefly around the central veins (Fig. 3) and many spore forming rods were found all through the tissue (Fig. 4). The kidneys showed some destruction of the tubular epithelium, but this was not striking. The other tissues showed nothing remarkable.

Fig. 7. The lesion of clostridium œdematoides in a guinea pig (one-half life size). The pig died from 16 to 20 hours after the injection of 0.5 cubic centimeter of a 20-hour culture into the lower midline of the abdominal wall. It produced an extensive jelly-like œdema of the whole abdominal wall which was hæmorrhagic around the point of inoculation.

At autopsy an opportunity was given one of us (F. L. M.) for obtaining material from the lesion for culture. The skin was painted with 7 per cent iodine and a fresh incision was made into the abdominal wall. Large pieces of the œdematous fat and muscle were excised for bacteriological study. This tissue yielded only two organisms, one aerobic, bacillus pyocyaneus, and one anaerobic which could not be identified. It was found that this anaerobe, in pure culture, produced a lesion in a guinea pig which was similar to the lesions caused by clostridium novyi and clostridium œdematis maligni, but which differed somewhat from them. It was further found that it was different from these other species in certain of its cultural characteristics. It became evident that the organism warranted further study to determine whether or not it was pathogenic for

Fig. 8. The lesion of clostridium œdematoides in a dog (about one-sixth life size). The dog died three days after the injection of 1.5 cubic centimeters of a 20-hour culture into the subcutaneous tissues of the abdominal wall just to the right of the midline. It produced an extensive hard, slightly hæmorrhagic œdema of the whole thickness of the abdominal wall resembling closely the lesion in the patient.

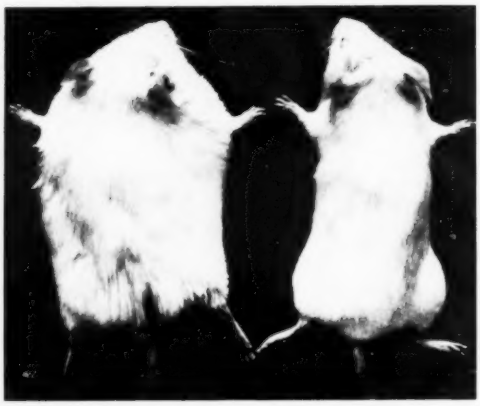

Fig. 9. The lesion of the toxin of clostridium œdematoides in mice. The mouse on the right died over night with a large dose of toxin. The mouse on the left died in 3 days with a small dose of toxin. The œdema is usually greatest when death occurs slowly.

other animals and whether or not it would maintain its pathogenicity over a period of time. It was also necessary to subject it to various cultural and serological tests to differentiate it from the other well known organisms of the gas gangrene group.

A DESCRIPTION OF THE ORGANISM

We have called this anaerobe clostridium œdematoides to indicate its similarity to the other organisms of this group.

MORPHOLOGY

Form. It is a large bacillus varying from 1 to 4 μ in length, and from 0.3 to 0.5 μ in width. The ends are square rather than rounded. It generally occurs singly, but may be in pairs or chains of three or four. Rarely short threads have been observed, corresponding in length to four or five individuals. It is strongly gram-positive in young cultures, but on further incubation or on standing some individuals become gram-negative (Fig. 5).

Spore formation. Spores are readily formed. They are generally paracentral but they may be central or subterminal. Spores are formed in large numbers in plain broth in 20 hours, but are not usually seen in 1 per cent dextrose broth until the third or fourth day of incubation. Many spores are present in 20-hour cultures in cooked meat medium without dextrose, and a fair number when 0.2 per cent dextrose is present in the meat medium. Whenever spores are found, a large proportion of them are free. Spores have been observed, but are very much less numerous, in the experimental lesions in animals and in the blood of animals killed by the infection.

Capsule formation. The vegetative forms have no capsule but the spores appear to have a thin capsule with the Hiss stain.

Motility. The organism is actively motile in young cultures. In cooked meat medium, both with and without 0.2 per cent dextrose, after four and a half hours of incubation, many motile forms are present. After 9 hours of incubation, the organisms in the dextrose medium are distinctly less motile, while in the medium without dextrose they are still very active. After 20 hours only a few actively motile individuals are seen even in the culture medium free from dextrose.

CULTURAL CHARACTERISTICS

Anaerobiosis. To obtain anaerobiosis for this study we have used a modification of the McIntosh and Fildes jar (6). This gives complete anaerobic conditions and permits the use of any media used in aerobic cultivation. Methylene blue in 1 per cent dextrose broth

is used as an indicator of the complete reduction of the atmosphere within the jar. This organism is a strict anaerobe. It grows as readily under anaerobic conditions as clostridium welchii and clostridium œdematis maligni. It does not require as complete anaerobiosis as clostridium novyi.

Growth on solid media. On 5 per cent sheep's blood agar in petri plates, the colonies are discrete and stellate with the long dimension generally in the direction of the streak made by the transplanting needle. The margin is very irregular (Fig. 6). Occasionally a fernlike spreading is seen from the edge of some of the colonies. When this was first observed, it was thought that there was a contaminating organism present, but repeated transplantations showed that such was not the case. It is believed that this fernlike spreading margin depends upon variations of moisture condensation on the surface of the media. The colonies are grayish in color. Rarely there is a slightly greenish tinge around the colony. No hæmolysis is evident but when the colony has been removed from the surface of the blood agar, there is a faint pallor to be seen in the underlying media. In agar tubes the deep colonies are small, discrete, and mossy. In dextrose agar, the medium is fragmented by the gas which is formed.

Fluid medium. In plain meat infusion broth it grows readily with a cloudy suspension increasing in density from the surface downward. When the tube is rotated it is seen that the growth has a thick, tenacious appearance and when it is taken up in a pipette, its mucoid character is evident. In dextrose broth, this is not present except in old cultures, and there seems to be a definite correlation between the mucoid character and sporulation. In cooked meat medium the mucoid character is again a prominent feature in old cultures. The growth is diffuse and gradually settles, but does not leave the supernatant fluid clear except after standing for several days. If left in the air at room temperature, the upper part of the supernatant fluid clears and a condensed ring 3 to 5 millimeters wide forms about 2 centimeters from the surface. Below this the suspension is thinner but increases in density down to the meat at the bottom.

Gelatin. When grown on gelatin, there is no rapid change, but liquefaction is complete in 48 hours.

Fermentative action. When grown on 1 per cent sugar media it is not active except in dextrose, in which it forms large quantities of gas and acid. Although growth is profuse in other sugar media, no acid and no gas are formed in lactose, saccharose, salicin, mannite, or glycerin.

Milk. With litmus as an indicator, milk shows a very slight purpling after 72 hours. There is no clotting but the medium becomes somewhat thicker. After 3 or 4 days' growth in milk there is evidence of partial digestion.

Proteolytic action. After prolonged incubation, there is slight surface erosion of Loeffler's medium but no real liquefaction. In meat medium there is no digestion of meat fibers although there is some darkening of the surface layer of the meat after some days. The odor of the gas produced on cooked meat medium is foul but not distinctive. It is not a butyric acid odor but rather resembles that of old cheese.

Thermal death point. It is well known that the thermal death point of spore forming organisms depends to some extent on the age of the culture and the reaction of the medium in which the culture is heated. Under certain constant conditions, however, the various species show some differences of resistance with considerable regularity. After growing for 20 hours in 0.2 per cent dextrose cooked meat medium, 5 drops are transferred to several tubes of fresh medium. These tubes may then be heated at different degrees of temperature for constant periods of time and then incubated in the usual way. Under such circumstances the spores of this organism resist 85 degrees C. for 15 minutes but are usually destroyed by 90 degrees C. for the same length of time.

PATHOGENICITY

Pathogenicity for laboratory animals. Clostridium œdematoides is lethal in small doses for mice, rats, guinea pigs, rabbits, cats, dogs, pigeons, and chickens. No other animals have been used. The effect has been so prompt in these animals that there is little doubt of its

TABLE I.—PATHOGENICITY OF CLOSTRIDIUM ŒDEMATOIDES—20-HOUR CULTURES WERE USED

	Death occurred
0.1 mil for 20-gram white mouse	Over night
0.25 mil for a 350-gram white rat	In 3 days
0.25 mil for a large pigeon	In 20 hours
0.25 mil for a 350-gram guinea pig	Over night
0.50 mil for a 2500-gram rabbit	In 20 hours
0.50 mil for a large chicken	In 30 hours
1.0 mil for a 4500-gram cat	In 3 days
1.5 mils for a 15-kilogram dog	In 3 days

general pathogenicity. When a 20-hour culture in 0.2 per cent dextrose cooked meat medium is injected subcutaneously into animals in doses ranging from 0.1 cubic centimeter for a 20-gram mouse to 1.5 cubic centimeters for a 15-kilogram dog, it kills the animal in from 10 to 72 hours. The organism may be recovered from the lesion, the peritoneum and the heart. The typical lesion in a guinea pig is an extensive, slightly hæmorrhagic œdema of the subcutaneous tissues (Fig. 7). It is not as extensive nor as colorless as the typical lesion of the clostridium novyi. It is not as hæmorrhagic and the muscles are not as red as the typical lesion of clostridium œdematis maligni. It is rather midway between these two with resemblances to both. Gas formation is minimal but is present to some degree in the muscle. The œdema is most marked when death occurs slowly. In the cat and in the dog, the lesion resembles the human pathology more closely than in the other animals. This may be due to the denser subcutaneous tissues in these animals. In cats and dogs, these tissues are enormously thickened with a rather firm but exceedingly moist œdema from which a serosanguineous fluid escapes on incision (Fig. 8). Not long before death, pigeons, guinea pigs, rabbits and mice, show a paralysis of the muscles. Clonic convulsions may develop immediately before the end.

The minimal lethal doses for these laboratory animals have not been determined. Fatal doses, all given subcutaneously, are shown in Table I.

The maintenance of pathogenicity for laboratory animals. The strain has been transferred scores of times on several different kinds of artificial media over a period of 2 years, and it has maintained its active pathogenicity.

TABLE II.—THE PROTECTIVE EFFECT OF THE IMMUNE SERUM

The sera and toxins were mixed and incubated for one hour at 37.5 degrees C. before subcutaneous inoculation.

Mouse	Results
1. Serum rabbit No. 49 (6 series subcutaneous inoculations) 0.25 mil +Clostridium œdematoides toxin 0.25 mil	Survived
2. Serum rabbit No. 48 (5 series intravenous inoculations) 0.25 mil +Clostridium œdematoides toxin 0.25 mil	Survived
3. Normal rabbit serum 0.25 mil +Clostridium œdematoides toxin 0.25 mil	Died over night
4. Plain broth 0.25 mil +Clostridium œdematoides toxin 0.25 mil	Died over night
5. Serum rabbit No. 49 0.10 mil +Clostridium œdematoides toxin 0.40 mil	Survived
6. Serum rabbit No. 49 0.05 mil +Clostridium œdematoides toxin 0.45 mil	Survived

Pathogenicity for man. A description of the human lesion both gross and microscopic is given in the case history. These findings were consistent with the clinical aspects of the case and seemed to indicate that the organism which was found, was responsible for the lesion and for the fatal outcome. Its occurrence in a fatal lesion in man, when considered with its pathogenicity for animals, would tend to lend weight to the belief that it is also generally pathogenic for man.

TOXIN PRODUCTION

The organism produces a true exotoxin, filterable, thermolabile, having a latent period and capable of stimulating an antitoxin when injected in sublethal doses into animals. Toxin is produced both in plain meat infusion broth and in cooked meat medium. It is somewhat more powerful in plain broth culture than in the meat medium and 20-hour cultures in both media yield more active toxins than cultures incubated for 1 week. The filtrate from a 20 to 24-hour culture in cooked meat medium with 0.2 per cent dextrose is highly toxic for mice, guinea pigs, and rabbits. The minimal lethal dose of this toxin for a 20-gram white mouse is approximately 0.02 cubic centimeter. The minimal lethal dose for a 350-gram guinea pig lies between 0.1 cubic centimeter and 0.25 cubic centimeter. The

TABLE III.—THE ABSENCE OF PROTECTION AGAINST CLOSTRIDIUM ŒDEMATOIDES TOXIN WITH POTENT CLOSTRIDIUM WELCHII, CLOSTRIDIUM NOVYI AND CLOSTRIDIUM ŒDEMATIS MALIGNI ANTITOXINS

The sera and toxins were mixed and incubated for one hour at 37.5 degrees C. before subcutaneous inoculation.

Mouse	Results
1. Clostridium welchii antitoxin 0.25 mil +Clostridium œdematoides toxin 0.25 mil	Died over night
2. Clostridium welchii antitoxin 0.25 mil +Clostridium œdematoides toxin 0.02 mil	Died in 36–48 hours
3. Clostridium novyi antitoxin 0.25 mil +Clostridium œdematoides toxin 0.25 mil	Died over night
4. Clostridium novyi antitoxin 0.25 mil +Clostridium œdematoides toxin 0.02 mil	Died in 72–80 hours
5. Clostridium œdematis maligni antitoxin 0.25 mil +Clostridium œdematoides toxin 0.25 mil	Died in 36 hours
6. Clostridium œdematis maligni antitoxin 0.25 mil +Clostridium œdematoides toxin 0.02 mil	Died in 56–64 hours

lesion in these animals which the toxin produces is chiefly a jellylike œdema not unlike that produced by the clostridium novyi. It has not the hæmorrhagic element seen in the lesion produced by the whole culture. When given in large doses the toxin kills promptly and there is very little œdema but in small doses the œdema increases gradually and is very marked at death, sometimes giving the appearance of mechanically choking the mouse (Fig. 9). One sublethal dose caused a mouse to swell up to almost twice its original size in 4 to 5 days with subsequent subsidence to normal. A mouse that is ill lies quietly with eyes closed and hair bristling. Respirations are deep and slow. As the œdema develops, all movements become slow and ponderous. Toward the end it falls over on its side or flattens out as if paralyzed. Occasionally there are a few spasms just before death. Intravenous injection of toxin in rabbits in several instances caused an exudation of fluid into the pleural, pericardial, and peritoneal cavities, with death.

The latent period of toxin action. There is no immediate effect following the injection of toxin. Even with large doses several hours elapse before there are signs of intoxication.

TABLE IV.—THE RECIPROCAL TESTS WITH CLOSTRIDIUM NOVYI AND CLOSTRIDIUM ŒDEMATOIDES SERA AND THEIR RESPECTIVE TOXINS

The sera and toxins were mixed and incubated for one hour at 37.5 degrees C. before subcutaneous inoculation.

Mouse	Results
1. Clostridium œdematoides serum 0.25 mil +Clostridium œdematoides toxin 0.25 mil	Survived
2. Clostridium œdematoides serum 0.25 mil +Clostridium novyi toxin 0.25 mil.	Died over night
3. Clostridium œdematoides serum 0.25 mil +Clostridium novyi toxin 0.05 mil +broth 0.20 mil	Died over night
4. Clostridium novyi serum 0.25 mil +Clostridium novyi toxin 0.25 mil.	Survived
5. Clostridium novyi serum 0.25 mil +Clostridium œdematoides toxin 0.25 mil	Died over night
6. Clostridium novyi serum 0.25 mil +Clostridium œdematoides toxin 0.05 mil +broth 0.20 mil	Died in 30–40 hours

The deterioration of toxin. The toxin gradually loses some of its potency even if kept sealed in the ice box. The minimal lethal dose of one filtrate increased from 0.02 to 0.05 in the course of a month. This deterioration takes place more rapidly at room temperature.

Thermolability of the toxin. The toxin is destroyed by boiling for 5 minutes or by heating at 56 degrees C. for 1 hour. It is greatly attenuated but not entirely destroyed by heating at 56 degrees C. for 30 minutes. Lower temperatures down to 37.5 degrees C. attenuate it slightly.

ANTITOXIN EXPERIMENTS

The antigenic properties of the toxin. Antitoxic serum may be obtained in rabbits either by intravenous or subcutaneous inoculation of the filtrate. The doses must be very small and the weight of the animals must be watched carefully. We obtained satisfactory results by the injection of a small dose daily for 3 days out of each week, starting with 0.5 mil and gradually increasing the dose with each series. After three series of subcutaneous injections the rabbit's serum showed weak protection. After five such series the serum proved to be of considerable potency. Nine days after the sixth series the animal was killed for serum, after having received 16.5 mils of the toxin in six weeks' time. Then it

TABLE V.—THE RECIPROCAL TESTS WITH CLOSTRIDIUM NOVYI AND CLOSTRIDIUM ŒDEMATOIDES SERA AND THE CENTRIFUGED SUPERNATANT FLUID OF THEIR RESPECTIVE CULTURES

The sera and centrifuged supernatant fluid were mixed and incubated for one hour at 37.5 degrees C. before subcutaneous inoculation.

Mouse	Results
1. Clostridium œdematoides serum 0.25 mil +0.25 mil of the centrifuged supernatant fluid of a 20-hour culture of clostridium œdematoides	Survived
2. Clostridium œdematoides serum 0.25 mil +0.25 mil of the centrifuged supernatant fluid of a 20-hour culture of clostridium novyi	Died over night
3. Clostridium novyi serum 0.25 mil +0.25 mil of the centrifuged supernatant fluid of a 20-hour culture of clostridium novyi	Survived
4. Clostridium novyi serum 0.25 mil +0.25 mil of the centrifuged supernatant fluid of a 20-hour culture of clostridium œdematoides	Died over night

was found that 0.05 mil of the serum would protect white mice against 0.45 mil of toxin (see Table II). Similarly after five series of intravenous injections with somewhat smaller doses, potent serum was obtained in another animal.

The protective effect of the immune serum. The following experiments, as shown in Table

TABLE VI.—THE RECIPROCAL TESTS WITH CLOSTRIDIUM ŒDEMATIS MALIGNI AND CLOSTRIDIUM ŒDEMATOIDES SERA AND THE CENTRIFUGED SUPERNATANT FLUID OF THEIR RESPECTIVE CULTURES

The sera and centrifuged supernatant fluid were mixed and incubated for one hour at 37.5 degrees C. before subcutaneous inoculation.

Mouse	Results
1. Clostridium œdematoides serum 0.25 mil +0.25 mil of the centrifuged supernatant fluid of a 20-hour culture of clostridium œdematoides	Survived
2. Clostridium œdematoides serum 0.25 mil +0.25 mil of the centrifuged supernatant fluid of a 20-hour culture of clostridium œdematis maligni	Died over night
3. Clostridium œdematis maligni serum 0.25 mil +0.25 mil of the centrifuged supernatant fluid of a 20-hour culture of clostridium œdematis maligni	Survived
4. Clostridium œdematis maligni serum 0.25 mil +0.25 mil of the centrifuged supernatant fluid of a 20-hour culture of clostridium œdematoides	Died over night

TABLE VII.—THE RECIPROCAL TESTS WITH CLOSTRIDIUM WELCHII AND CLOSTRIDIUM ŒDEMATOIDES SERA AND THE CENTRIFUGED SUPERNATANT FLUID OF THEIR RESPECTIVE CULTURES

The sera and centrifuged supernatant fluid were mixed and incubated for 1 hour at 37.5 degrees C. before intraperitoneal inoculation.[1]

Mouse	Results
1. Clostridium œdematoides serum 0.25 mil +0.25 mil of the centrifuged supernatant fluid of a 20-hour culture of clostridium œdematoides	Survived
2. Clostridium œdematoides serum 0.25 mil +0.25 mil of the centrifuged supernatant fluid of a 20-hour culture of clostridium welchii	Died over night
3. Clostridium welchii serum 0.25 mil +0.25 mil of the centrifuged supernatant fluid of a 20-hour culture of clostridium welchii	Survived
4. Clostridium welchii serum 0.25 mil +0.25 mil of the centrifuged supernatant fluid of a 20-hour culture of clostridium œdematoides	Died over night

[1]An intraperitoneal instead of a subcutaneous inoculation was used in this test because the clostridium welchii toxin was relatively weak.

II, demonstrate the potency of this new immune rabbit serum against the toxin produced by this organism.

The absence of protection against this toxin by potent clostridium welchii, clostridium novyi and clostridium œdematis maligni antitoxins. Antisera for clostridium welchii, clostridium novyi and clostridium œdematis maligni, which had previously been demonstrated to be potent in protecting white mice against the toxins of these respective organisms, were tested for protective action against this toxin and found to have no effect (Table III).

The reciprocal tests with clostridium novyi and clostridium œdematoides sera and their toxins. When these sera were tested against the toxins produced by the homologous and the heterologous species, it was found that they were potent against the former but impotent against the latter. These experiments are shown in Table IV.

The reciprocal tests with clostridium novyi and clostridium œdematoides sera and their unfiltered cultures. When these sera were tested against the centrifuged supernatant fluid of 20-hour cultures containing not only toxin but living organisms, the results again

TABLE VIII.—A DIFFERENTIAL CHART SHOWING THE CULTURAL CHARACTERISTICS OF THE PATHOGENIC ANAEROBIC BACILLI OF THE GAS GANGRENE GROUP

Name of species	Spores	Growth on blood agar	Saccharolysis					Proteolysis
			Dex.	Lac.	Sac.	Sal.	Gly.	
Clostridium welchii (bacillus aerogenes capsulatus)	±	Discrete round	+	+	+	o	+	o
Clostridium œdematis maligni (Vibrion septique)	+	Spreader	+	+	o	+	o	o
Clostridium novyi (bacillus œdematiens)	+	Discrete irregular	+	o	o	o	+	o
Clostridium œdematoides (new species)	++	Discrete stellate	+	o	o	o	o	±

showed strictly specific protection. This is shown in Table V.

The reciprocal tests with clostridium œdematis maligni and clostridium œdematoides sera and their unfiltered cultures. The experiments described in the preceding paragraph were repeated with the sera of clostridium œdematis maligni and clostridium œdematoides, with almost identical results. These are shown in Table VI.

The reciprocal tests with clostridium welchii and clostridium œdematoides sera and their unfiltered cultures. The experiments described in the preceding paragraph were repeated with the sera of clostridium welchii and clostridium œdematoides with similar results. It was found that 0.25 mil of the centrifuged supernatant fluid of the clostridium welchii culture was not sufficient to kill the mouse when injected subcutaneously, but when the experiment was repeated with intraperitoneal injections, the specific homologous protection was evident. The results in this experiment are shown in Table VII.

The differentiation of clostridium œdematoides from the other pathogenic anaerobic bacilli. The foregoing experiments with toxins and antitoxins conclusively demonstrate that this organism represents a species distinct from clostridium welchii, clostridium novyi and clostridium œdematis maligni, but for preliminary differentiation, the cultural differences between these pathogenic anaerobes are of prime importance. One may distinguish clostridium œdematoides from the others by the following differences.

1. From clostridium welchii by (a) the differences in the colony growth on blood agar. (Clostridium welchii, if hæmolytic, produces a narrow zone of complete hæmolysis about the colony and a wide zone of partial hæmolysis. The non-hæmolytic strains produce the outer zone only. The colonies are usually round.) (b) The absence of fermentation of glycerin with the formation of acrolein. (c) The absence of acid and gas production with lactose and saccharose. (d) The absence of butyric acid odor in dextrose medium. (e) The greater tendency to spore formation.

2. From clostridium œdematis maligni (vibrion septique), by (a) the differences in the colony growth on blood agar. (Clostridium œdematis maligni usually spreads over the plate in a thin film and most strains are hæmolytic.) (b) The absence of fermentation of lactose and salicin. (c) The greater tendency to free spore formation.

3. From clostridium novyi (bacillus œdematiens), by (a) the differences in the colony growth on blood agar. (Clostridium novyi usually forms distinctly green colonies which are often slightly hæmolytic.) (b) The absence of prompt flocculation in fluid media. (c) The absence of fermentation of glycerin. (d) The greater tendency to free spore formation.

These cultural differences are shown in Table VIII.

THE SOURCE OF THIS ORGANISM

How this organism entered the body of the patient is a question of great importance. The circumstances were such as to point to an operating room infection. Within a period of 4 days after this case was operated on, four other clean cases *in the same hospital*, cared for by two other surgeons developed fatal operative wound infections of the gas gangrene type. These surgeons have very kindly consented to our including in this paper very

TABLE IX.—THE PROTECTIVE ACTION OF CLOSTRIDIUM ŒDEMATOIDES SERUM ON THE TOXINS FROM CULTURES OF THE CATGUT STRAINS

The sera and the toxins were mixed and incubated for one hour at 37.5 degrees C. before subcutaneous inoculation.

Mouse	Results
1. Clostridium œdematoides serum (rabbit No. 49) 0.25 mil +toxin from catgut strain No. 1, 0.25 mil	Survived
2. Clostridium novyi serum 0.25 mil +toxin from catgut strain No. 1, 0.25 mil	Died over night
3. Normal rabbit serum 0.25 mil +toxin from catgut strain No. 1, 0.25 mil	Died in 30 hours
4. Clostridium œdematoides serum (rabbit No. 49) 0.25 mil +toxin from catgut strain No. 2, 0.25 mil	Survived
5. Clostridium novyi serum 0.25 mil +toxin from catgut strain No. 2, 0.25 mil	Died in 36 hours
6. Normal rabbit serum 0.25 mil +toxin from catgut strain No. 2, 0.25 mil	Died over night

brief résumés of their cases. In all of these cases chromic catgut was used for suturing the fascia of the abdominal wall.

CASE 1. The patient was a male, age 37. A right inguinal hernia repair and an appendicectomy through a right rectus incision were done. The convalescence was normal for 7 days. On the eighth day, the rectus wound became slightly indurated but was not painful. The temperature rose to 101 degrees F. and the pulse to 90. On the ninth day, patient complained of pain in upper incision. The induration had spread and the whole region was very tender. An opening made in the wound failed to reveal pus. Next day the process was intensely painful and the edges of the wound were extremely œdematous. The wound was then opened widely and dark blood and gas escaped from it. The temperature mounted to 103 degrees F. and the pulse to 120. Leucocytosis was high. On the twelfth day, 4 days after the onset of symptoms, the patient became cyanotic and the skin cold and clammy. Nausea and impairment of vision developed. The indurated area took on a brownish color and extended downward involving the scrotum. Aerobic blood cultures were negative. On this day the patient died. No cultures were made from the wound. No autopsy was obtained.

CASE 2. The patient was a female, age 29. A cholecystectomy and an appendicectomy were done through an upper right rectus incision. With the exception of slight elevation of temperature and pulse, her condition was satisfactory until the fourth day, when her temperature rose to 103.2 degrees F. and her pulse to 120. There was marked swelling about the upper part of the wound. The patient became nauseated and perspired excessively. She was very restless and apprehensive. On the fifth day her temperature again reached 103 degrees F. and the pulse at the wrist became imperceptible. The whole wound became indurated and œdematous, but there was no discoloration of the skin. During the fifth day, the patient became nauseated, irritable, and restless. She developed a profuse cold perspiration, became more and more prostrated and died. Cultures of the wound and blood were not taken and there was no autopsy.

CASE 3. The patient was a female of 25. A Gilliam suspension of the uterus and a left oophorectomy were done. She did well for 4 days. On the fifth day the temperature mounted to 101 degrees F. and the pulse to 128. She complained of abdominal pain and felt nauseated, weak, and nervous. There was profuse perspiration. The tissues about the abdominal wound were indurated and had a brownish discoloration. The pulse became progressively weaker and she died on the sixth day. Cultures of the wound and blood were not made, and there was no autopsy.

CASE 4. The patient was a female, age 20. A ventral suspension of the uterus and an appendicectomy were done. She made an uneventful recovery in the hospital and was discharged, apparently well, on the thirteenth day after operation. Five days after her discharge, she was again admitted to the hospital because of pain and induration about her abdominal wound. Her temperature was 100 degrees F. and her pulse 90. The tissues about her wound were of the consistency of tanned leather. The wound was opened and drained but no pus was obtained. The tissues were infiltrated with serosangineous fluid. Microscopic examination of a piece of the fat showed extensive hæmorrhagic and œdematous changes with some necrosis of the fat, and moderate degree of leucocytic infiltration. Aerobic and anaerobic cultures from the wound were negative in 72 hours, but inoculation of the fluid into a guinea pig was followed by the death of the pig in 48 hours with œdema at the site of injection. Aerobic and anaerobic cultures from the guinea pig were negative. The patient did not improve after the wound was opened. Three days later multiple incisions were made into the involved abdominal wall. Aerobic and anaerobic cultures were again negative. Her temperature and pulse gradually rose and she died, 5 days after her second and 18 days after her first operation. No autopsy was performed.

As soon as these cases appeared, an investigation of the operating room technique was instituted by members of the hospital staff. The catgut then in use was all removed and another brand was substituted. Some of the confiscated catgut was sent to an outside bacteriologist who reported that one of the

tubes contained a pathogenic anaerobe which he classified as clostridium novyi.

When we had completed the study of the species described above and had demonstrated that it was not the clostridium novyi, we were eager to make a further study of the catgut. The hospital authorities very kindly furnished us with four tubes of the same batch of catgut. This fortunately had been kept in the bacteriological laboratory since its original removal from the operating room. This catgut was put out in sealed tubes by a reputable firm. In the box containing these tubes were directions stating that the catgut might be used after sterilization of the surface of the tubes. Two of these tubes contained No. 2 chromic catgut and two contained No. 3 chromic catgut. The tubes were flamed and broken. The gut was then quickly transferred to cooked meat medium and incubated anaerobically. From one of the No. 2 chromic tubes were cultured an organism resembling clostridium œdematoides and bacillus subtilis. From the second tube of No. 2 chromic catgut were cultured an organism resembling clostridium œdematoides and a hæmolytic strain of clostridium welchii. From one of the No. 3 chromic tubes was cultured the non-pathogenic anaerobe clostridium tertium. From the other tube of No. 3 chromic catgut was cultured a hæmolytic strain of clostridium welchii which was culturally different from the clostridium welchii obtained from one of the No. 2 chromic tubes. Thus out of four tubes of the batch of catgut used in the operation room at the time of these five fatal operative wound infections, four strains of pathogenic anaerobes, one strain of a non-pathogenic anaerobe and one strain of an aerobic sporeformer were cultured.

The two strains resembling clostridium œdematoides were then put through a series of cultural tests and they were found to be exactly similar to the strain cultured from the patient. Moreover, filtrates from these cultures and centrifuged supernatant fluids killed mice in the same way and the lesion in guinea pigs could not be distinguished from the lesion produced by the strain of clostridium œdematoides obtained from the patient. Also, the antitoxin prepared against the original strain protected mice from the filtrates and the supernatant fluids of 24-hour cultures of both of the catgut strains, whereas the clostridium novyi antiserum had no effect. These toxin-antitoxin experiments are shown in Table IX. Thus we were able to demonstrate that the two catgut strains were also clostridium œdematoides.

COMMENT

All of these cases were obviously operative wound infections. The failure to obtain positive cultures during life simply means that the methods which were used were not adequate. Even though the œdema fluid in supplementary case No. 4 killed a guinea pig in 48 hours, the organism was not obtained from it at autopsy. It has been observed that the œdematous tissue in the periphery of a clostridium novyi lesion may yield no growth on culture. The œdema is believed to be chiefly a toxic reaction. The organisms may not invade to the periphery. The failure to obtain growth from the œdema fluid or a bit of fat does not mean that the organisms were not present in the lesion during life. The patchy distribution of the organisms as seen in the microscopic slides of the subcutaneous fat of the patient, as mentioned above, is of interest in this connection. The negative results from the surface cultures in our case, taken several days after the wounds had been made, were not surprising. These preliminary failures emphasize the necessity for taking large quantities of material in all anaerobic culture work.

It is of significance that chromic catgut was used in our patient only for the aponeurosis of the rectus sheath—plain catgut being used in the peritoneal cavity. The infection arose in, and for a time was limited to, the abdominal wall while the peritoneum and the region of the appendix were quite free.

The infection began at the end of the first week in our patient and at widely varying times in the other cases. This would suggest that the spores were released from the catgut at varying lengths of time as it became absorbed. The cases varied also in their clinical manifestations. Certainly the descriptions of two of them suggest a clostridium welchii

infection, while the other two suggest infection with clostridium œdematoides, clostridium novyi or clostridium œdematis maligni. The finding of clostridium novyi by another bacteriologist and our finding of four or five different types of spore-forming organisms in the catgut, bring out the fact that in a group of infections such as these the causative organisms may well be different and yet come from one general source.

Dr. Welch has informed one of us (F. L. M.) that in the early days of Johns Hopkins Hospital on several occasions gas gangrene infections were traced presumably to catgut. It was on this basis that Dr. Halsted insisted upon the exclusive use of silk for suture and ligature material in his clinic. As the technique of preparation of catgut improved, some of the other clinics reverted to the use of absorbable material and have continued to use it.

It is evident that this batch of catgut was not properly sterilized—the non-sporeformers were doubtlessly killed but the spores survived. This represents a break in the technique of preparation which may have existed for an indeterminate period of time. Whether this time was long or short, it was sufficiently long to have certain dire consequences. The whole circumstance emphasizes the necessity for every manufacturer of catgut formulating and carrying out with the utmost meticulous care a technique for rigidly testing by adequate aerobic and anaerobic methods each and every batch of catgut put out on the market.

The general significance of this new species can be brought out only by an extensive study of material from many sources to determine its general distribution. This will be attempted.

SUMMARY

1. A pathogenic anaerobic bacillus of the gas gangrene group which, as far as we know, has not been heretofore described, has been recovered from the lesion in a fatal human operative wound infection in which no other pathogenic organisms were found.

2. The clinical syndrome was characterized by a brawny, red, œdematous swelling of the abdominal wall around the wound, severe pain in the lesion, elevation of temperature, leucocytosis, feeble and rapid pulse, nausea, profuse perspiration and toward the end somnolence, irritability when aroused, and finally profound prostration and circulatory failure.

3. The organism cultured from the human lesion is highly pathogenic for the eight different species of laboratory animals which we tested. It has maintained its pathogenicity for these animals over a period of 2 years with frequent transfers on artificial media.

4. It produces an extensive œdematous slightly hæmorrhagic lesion around the site of injection, somewhat resembling the lesions caused by clostridium novyi (bacillus œdematiens) and clostridium œdematis maligni (vibrion septique).

5. It may be recovered after the death of the animals, from the lesion, the peritoneum, and the blood.

6. It differs in some of the fundamental cultural tests from the other well known pathogenic anaerobic bacilli.

7. It produces a true exotoxin.

8. Potent antitoxic sera for clostridium welchii toxin, for clostridium novyi toxin and for clostridium œdematis maligni toxin have no protective action against the toxin produced by (or the culture of) this organism.

9. Potent antiserum has been produced in rabbits by injecting small doses of the toxin of this organism either intravenously or subcutaneously.

10. This antitoxin has no protective action against the toxins or the cultures of typical strains of clostridium welchii, clostridium novyi or clostridium œdematis maligni.

11. Therefore the organism appears to be a highly pathogenic anaerobe of the gas gangrene group distinct from the other three well known species: clostridium welchii, clostridium novyi and clostridium œdematis maligni.

12. Four other fatal cases of clinical gas gangrene developed at the same time in the same hospital. These cases were operated on within 4 days of the time at which the case we present was operated upon.

13. The chromic catgut in use in the operating room at that time yielded on culture clostridium novyi in the hands of another bacteriologist and in our hands yielded

two strains of this newly described species, two different strains of hæmolytic clostridium welchii and two other non-pathogenic spore-forming organisms.

14. The evidence seems to point toward chromic catgut, not properly sterilized, as the source of organisms producing this series of fatal gas gangrene infections.

15. These findings call for the establishment of adequate aerobic and anaerobic methods on the part of the manufacturers for the absolute demonstration of sterility of every batch of catgut put upon the market.

BIBLIOGRAPHY

1. Bull, C. G., and Pritchett, I. W. Toxin and antitoxin of, and protection against, bacillus welchii. J. Exper. Med., 1917, xxvi, 119. Identity of the toxins of different strains of bacillus welchii and factors influencing their production in vitro. Ibid., 867.
2. Bulloch, W., et al. Report on the anaerobic infections of wounds. Brit. M. Research Com. Special report series. 1919.
3. Hall, I. C. Differentiation and identification of the sporulating anaerobes. J. Infect. Dis., 1922, xxx, 445.
4. Henry, H. An investigation of the cultural reactions of certain anaerobes found in wounds. J. Path. & Bacteriol., 1916–17, xxi, 344.
5. McIntosh, J., and Fildes, P. The classification and study of the anaerobic bacteria of war wounds. Brit. M. Research Com. Special report series No. 12. 1917.
6. McIntosh, J., and Fildes, P. A new apparatus for the isolation and cultivation of anaerobic micro-organisms. Lancet, Lond., 1916, i, 768.
7. Robertson, M. Notes upon certain anaerobes isolated from wounds. J. Path. & Bacteriol., 1915–16, xx, 327.
8. Sacquepee, E. Sur la gangrène gazeuse. Presse méd., 1915, xxiii, 218. Recherches sur la gangrène gazeuse des plaies de guerre. Ibid., 1918, xxvi, 197.
9. Weinberg, M., and Seguin, P. La gangrène gazeuse. pp. 444. Paris: Masson et Cie, 1918.
10. Welch, W. H., and Nuttall, G. H. A gas producing bacillus (bacillus aerogenes capsulatus, nov. spec.) capable of rapid development in the blood vessels after death. Johns Hopkins Hosp. Bull., 1892, iii, 81.

ABDOMINAL SYMPTOMS OF HEART DISEASE, WITH SPECIAL REFERENCE TO THE RÔLE OF AURICULAR FIBRILLATION

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THERE are certain groups of patients suffering from cardiovascular disease who, because of the predominance of abdominal symptoms, often present themselves to a surgeon. In many instances the presence of heart disease has been recognized by the surgeon, but he has not been fully aware of the frequency and variety of abdominal symptoms that may be secondary to certain purely cardiac affections. The syndrome called abdominal angina is well known and has been greatly clarified in recent years by the re-discovery of coronary occlusion as a clinical entity. Although the differentiation of abdominal pain due to the disease of the coronary arteries from that caused by some acute disturbance of the abdominal viscera is still not only difficult but at times impossible, the very recognition of the fact that the heart may be the cause of severe abdominal pain or even the picture of shock, as often occurs in coronary occlusion, has meant a distinct advance in the solution of individual problems. When it is available, an electrocardiogram may help in establishing or excluding a recent ventricular infarction resulting from coronary occlusion. Children suffering from Hennoch's purpura, with or without endocardial involvement, occasionally come first to the surgeon. In recent years, I have seen two cases, the first of whom was operated upon for acute appendicitis. It should also be borne in mind that in children, nausea, vomiting, and abdominal pain may announce acute pericarditis. Attacks of paroxysmal tachycardia are occasionally attended by epigastric pain and, if the heart rate be not excessive, the determination of the underlying cause of pain may be difficult.

There is, however, a phase of cardiac pathology frequently seen by the surgeon, the mechanism of which is much simpler than that involved in the groups previously mentioned. It has to do with one of the functions of the liver, the capacity of that organ to act as a reservoir. Cardiac failure is still too often considered synonymous with gross œdema of the extremities. In reality, the most common sign of a failing heart is enlargement of the liver due to passive congestion and, I submit as a corollary, the most common cause of enlargement of the liver is passive congestion. Certainly, failure to exclude passive congestion of the liver as the cause of abdominal symptoms has at times led to the performance of a laparotomy that had been better left undone. For example:

Case No. 2084. This patient complained of epigastric pain, general weakness, loss in weight, cough at night, and dyspnœa on exertion. These symptoms were of 5 months' duration. The heart was enlarged. The liver extended 5 centimeters downward. The lungs showed emphysema, but no congestion. An X-ray examination of the gastrointestinal tract showed no evidence of disease. At a later examination, there was no enlargement of the liver, but because of loss in weight, anæmia and epigastric distress, the diagnosis of possible malignancy of the stomach was made, and laparotomy was performed. A so-called "chronic appendix" was removed. The patient made a good recovery from the operation only to return to the hospital 1 month later with gross cardiac failure. The key to the diagnosis in this case was the decrease in the size of the liver after rest in bed.

A friend working in another clinic has given me permission to describe a recent experience of his.

Six days after tonsillectomy, the patient developed cramp-like pains in the abdomen. He took purgatives without relief and returned to the hospital. He had pains in the joints but no limitation of motion. A diagnosis of mitral stenosis was readily made. The temperature was 102 degrees, the pulse rate, 120, and the leucocyte count, 19,000. There was tenderness and muscle spasm in the right upper quadrant of the abdomen and less marked tenderness in the right lower quadrant. At the first examination, the liver was not palpable owing to muscle spasm. Laparotomy was performed at

once, and a normal appendix was removed. The following day, the liver edge was readily felt below the costal margin. Under salicylates and digitalis, the patient became symptom-free. The final diagnosis made was acute rheumatic fever, chronic valvular disease and chronic endocarditis.

Abdominal symptoms arising from congestion of the liver are more frequently seen in cardiac patients with auricular fibrillation. This may be defined as a disturbance of the cardiac mechanism in which the normal pace-maker has been replaced by a rapid circus movement, which results in the cessation of co-ordinated auricular systole and in rapid, irregular ventricular beating. The evidence for the theory of the circus movement and the possible factors responsible for initiating this movement need not be reviewed here. Fibrillation may appear in any type of diseased heart; its pathology is entirely chemical and it is not related to any specific structural change. The heart lesions with which fibrillation is most often associated are mitral stenosis, the arteriosclerotic heart, the thyroid heart, the hypertensive heart, and, less commonly, the syphilitic heart. It may appear as a transient disturbance in the course of infection or, as will be pointed out later, follow the stress of operative procedures. The establishment of the abnormal rhythm occurs instantly, that is in a time interval which only slightly exceeds that between two normal beats. Clinical recognition of this mechanism is almost always easy. The presence of auricular fibrillation is to be suspected in any irregular heart, beating at a rate of 120 or more. In untreated cases, there is almost always a disparity between the apex and radial rates. With the onset of fibrillation, co-ordinated auricular systole that is mechanically effective ceases; there is virtual auricular paralysis. Then there ensues distention of the great veins and backing up of blood in the liver, which acts as a reservoir. So completely may the liver compensate for the inadequacy of the pump by removing a large volume of blood from the general circulation, that these patients may show not only absence of œdema but even no congestion of the lungs and slight or no cyanosis. The accumulation of blood in the liver may occur so rapidly that the capsule is suddenly distended, producing acute pain in the upper abdomen. More commonly there follows chronic passive congestion of the liver and portal stasis. The usual purely cardiac symptoms, palpitation and dyspnœa on exertion, may be relatively slight and even overshadowed by the abdominal symptoms—pain, swelling of the abdomen, nausea and vomiting, or less definitely, indigestion or flatulence. That such a sequence of events might have a purely surgical aspect was first impressed on me some years ago when I saw a man who had been operated upon by a competent surgeon for supposed gall-bladder disease. The gall bladder was found to be normal, and it was later apparent that the symptoms had been due to engorgement of the liver secondary to auricular fibrillation. These points may be illustrated by reference to a few cases.

CASE NO. 162. The patient, who was a salesman and did much walking, had been in good health. Having just eaten breakfast, he stooped down to poke the fire and as he did so, he experienced severe pain in the region of the liver. He was nauseated and vomited. The family doctor was called and said that the man had acute appendicitis. He was kept in bed for 3 weeks with ice on the abdomen. On resuming work he suffered from shortness of breath, cough, and soreness in the upper abdomen. There had been no œdema. He then came to the hospital and was found to have mitral stenosis with auricular fibrillation. The apex rate was 147 and the radial rate, 85. He showed moderate congestion of the lungs and a large and tender liver.

CASE NO. 253. While working in a coal mine, this man was seized with severe abdominal pain, weakness, cough and shortness of breath, so that he had to be carried to his home. He had always been well and strong and had worked in a coal mine for 20 years. He was sent to the hospital and admitted to the surgical service with a diagnosis of acute appendicitis. This patient also had mitral stenosis with auricular fibrillation. The liver was enlarged and very tender to pressure. There was no moisture in lungs, but deep cyanosis of the lips and fingers.

CASE NO. 324. The patient's principal complaint was pain in the middle of the abdomen which came on suddenly while working as a laborer and had persisted for 7 months before he came to the hospital. There had been no œdema, and only a short time before he was seen, had he noticed shortness of breath on exertion. Auricular fibrillation was present. The liver extended to the umbilicus and was tender to pressure. After he had taken 24 cubic centimeters of tincture of digitalis, the

abdominal pain and gastric distress after eating entirely disappeared and the liver was no longer palpable.

The following is an illustration of a more chronic type of portal stasis.

CASE NO. 121. This patient came to the hospital complaining of epigastric pain. The pain was not definitely related to the taking of food. Five months before, he had been injured in a coal mine and 3 days later there developed swelling of the abdomen so that he was obliged to give up his work. Auricular fibrillation was found to be present, with a large and tender liver. There was no cyanosis, no congestion of the lungs, and no œdema. The apex and radial rates were 80. The gastric acidity was low. With a clinical diagnosis of peptic ulcer, the man was sent for X-ray study. The obliging skiagrapher said he suspected an ulcer on the lesser curvature of the stomach, which was probably malignant. The surgeon was persuaded to withhold operation and after the administration of digitalis all symptoms disappeared.

It may be pointed out that in long-standing cases of passive congestion of the liver associated with auricular fibrillation, with treatment the size of the organ may decrease, but in many the liver remains large and can always be readily palpated.

On the other hand, it is well known that some patients have auricular fibrillation for many years, and even untreated, remain quite free from symptoms. Thus fibrillation may appear in surgical patients in the rôle of an innocent bystander. For example:

CASE NO. 923. The patient was a coal miner who came to the hospital because of a contusion of one arm sustained at his work. He did not know of anything wrong with his heart. He had slight dyspnœa on exertion and cough with expectoration, not unusual symptoms in a coal miner of 53 years. The heart was not enlarged. There was only slight elevation of blood pressure and there were no signs of congestive failure, but auricular fibrillation was present.

Then there is the difficult group of cases of organic heart disease in which fibrillation may be present temporarily as the result of some added morbid process or the patient may have fibrillation permanently established for his cardiac mechanism and symptoms due to independent abdominal disease. Great care is required in these patients to establish the presence of unrelated diseases.

CASE NO. 549. This patient, who had suffered from flatulence for several years, complained of epigastric distress, then general abdominal cramps, nausea and vomiting, and finally attacks of right upper abdominal pain, so severe that morphine was required. He had had rheumatic fever in youth. The liver was enlarged and there were reasons for suspecting cirrhosis. Auricular fibrillation was present. A diagnosis of suppurative cholecystitis was made, and under local anæsthesia, one pint of pus was removed from beneath the left lobe of the liver and the gall bladder, which also contained pus, was drained. During convalescence, the fibrillation ceased. One year later, the man returned to the hospital to die of empyema. No recurrence of the fibrillation was observed.

CASE NO. 46. For years, the patient suffered from indigestion, flatulence and discomfort in the upper right abdomen. Finally he had attacks suggestive of gall-stone colic, but no jaundice. There was present at that time a cardiac irregularity which was later shown to be auricular fibrillation. The gall bladder was opened and drained; sand and small stones were found. Relief of indigestion and constipation followed. Thirteen years later the man died of cardiovascular renal disease. The auricular fibrillation persisted throughout this period.

The occurrence of auricular fibrillation as a postoperative complication is in itself an interesting subject. This disturbance of mechanism occurs most commonly following operations on the thyroid gland, but may occur in any type of heart disease. The disorder is usually transient. In my experience, I have never seen a patient who developed postoperative fibrillation who did not, because of, or in spite of the treatment administered, revert to normal cardiac rhythm. It has been taught that transient fibrillation should not be treated with digitalis. This teaching is based on the fact that both experimentally and clinically digitalis may produce fibrillation. Accidentally or wilfully, I have poisoned many people with digitalis, but only once have I seen auricular fibrillation result from excessive use of the drug. Many times I have seen fibrillation occurring in the course of pneumonia, of thyroid disease, and after operation, cease following the administration of digitalis. It is my impression, though unfortunately the question does not lend itself to proof, that the pre-operative use of digitalis in patients with diseased hearts may guard against the development of auricular fibril-

lation as a postoperative complication. On a few occasions, the use of quinidine sulphate has been apparently successful in stopping postoperative fibrillation. One example will illustrate this phase of the problem.

CASE NO. 1524. This patient was a woman, 50 years of age, who suffered from chronic valvular disease, probably mitral stenosis. Previous to the operation, electrocardiographic examination showed an arrhythmia due to auricular premature beats. It is well known that this disturbance often occurs as a forerunner of the more serious disorder, fibrillation. On November 19, 1925, a stone was removed from the lower calyx of the left kidney both local and ether anæsthesia being used. Following the operation, 8 cubic centimeters of tincture of digitalis were given per rectum. On the morning of the following day, the blood pressure was 120-70. The heart rate was 82 and an occasional premature beat was still present. The second day after the operation, the packing was removed from the wound. This was associated with great pain. Shortly after this, the nurse noticed a change in the pulse. Examination showed that auricular fibrillation had developed. The apex rate was 130 and the radial rate, 118. The blood pressure was 115-50. That afternoon and evening, three doses of quinidine sulphate, 0.2 gram, were given and sufficent morphine to secure rest that night. When examined the next noon, the cardiac rhythm was normal and remained so during the stay in the hospital. On April 1, 1926, while she was stooping over when working in the garden, fibrillation recurred and persisted until death, which occurred suddenly in December, 1926.

There is one other primary cardiac disease which I have found to have significance for the surgeon; that is subacute bacterial endocarditis. The diagnosis of this affection in the early stages, before embolic phenomena have appeared, may be difficult. The problem may be illustrated by the following case histories.

CASE NO. 1768. A woman of 52 years complained of dull pain and a sense of heaviness in the upper left abdomen and left side, which at times was referred to the left back and to the precordial area. This pain had been present for about one year during which she had spent most of the time in bed. She had lost 60 pounds in weight. She ran an irregular temperature which often rose to 100 degrees. Anæmia was not marked and there was no leucocytosis. The presence of mitral stenosis with auricular fibrillation was readily diagnosed. There was slight enlargement of the liver and the spleen was readily palpated. The fingers at first showed raised and rounded nail bases; frank clubbing soon developed. On the left palm were two, slightly swollen, round, tender areas of reddish discoloration, probably caused by bacterial emboli. And finally, the blood culture yielded streptococci. In this, as in all cases described, apparently the first diagnostic measure employed by the surgeon has been the X-ray study of the gastro-intestinal tract. This procedure has always proved useless, and always expensive. This patient's abdominal symptoms were due to splenic infarction and perisplenitis.

CASE NO. 2287. A child of 13 years had been ill of heart disease for 1 year. For several weeks she had had fever. She was suddenly seized with severe cramp-like pains in the center of the abdomen, accompanied by nausea and vomiting. Morphine was given and the child was brought to the hospital. There was general abdominal rigidity which could be overcome by pressure to a certain extent. Tenderness to pressure appeared most pronounced in the left hypochrondrium. The heart showed enlargement and a systolic murmur. The leucocyte count was 22,000. The following day, the surgeon thought that the tenderness and rigidity were more definite over McBurney's point and a laparotomy was performed. A normal appendix was removed and the gall bladder was normal. Convalescence was normal for 2 weeks when there was a return of the abdominal pain and of fever. The child had definite signs of mitral stenosis, frank clubbing of the fingers and slight clubbing of the toes. The spleen was not palpable and had not been examined at operation. The blood cultures were negative, but there seems little doubt that the acute abdominal symptoms in this case resulted from infarction of the spleen.

CASE NO. 634. The patient was a man of 21 years in whom a diagnosis of subacute bacterial endocarditis had been fully established. He developed tenderness over McBurney's point and on this account, laparotomy was performed. There was no evidence of inflammation about the appendix. The patient made a good recovery from the operation.

CASE NO. 24. The patient complained of epigastric pain and tenderness. He ran an irregular septic temperature. Aortic insufficiency was present. There was high-grade anæmia without leucocytosis. A diagnosis of subacute bacterial endocarditis was made by one physician, but this was overruled because of the slow heart rate. The right costophrenic angle was opaque and the question of a subdiaphragmatic abscess was raised. Laparotomy was performed. No abscess was found, but the liver was enlarged and there was a large infarcted spleen. The patient died 2 days after the operation.

In addition to the cases of congestive heart failure and of bacterial endocarditis, who have successfully withstood laparotomy, I recall three patients with coronary disease and true angina pectoris in whom the gall

bladder was drained or removed with benefit to the patient, and a case of coronary occlusion who recovered from amputation of a leg, which had to be done because of popliteal thrombosis. Such examples may afford comfort to the surgeon when patients suffering from severe heart disease present indications for surgical interference.

SUMMARY

Because of predominatingly abdominal symptoms, patients suffering from primary cardiovascular disease frequently first seek relief from surgeons. These abdominal symptoms comprise two groups. In one, the origin of the symptoms is purely reflex, as the abdominal pain, nausea, vomiting, seen in disease of the coronary arteries or acute inflammations of the heart. In the other, there are secondary changes in the abdominal viscera which are responsible for the symptoms. In this group, symptoms dependent on acute or chronic passive congestion of the liver and portal stasis are common. They occur frequently as a result of auricular fibrillation and the impairment of the circulation dependent on the arrhythmia itself offers a ready explanation. Abdominal symptoms resulting from infarction of the spleen and perisplenitis occurring in subacute bacterial endocarditis have been observed, and three patients in whom laparotomy was performed have been recorded.

Patients suffering from cardiovascular disease may develop any known abdominal disease but because of the frequency and variability of abdominal symptoms in purely cardiac cases, the burden of proof is on the establishment of an independent pathological process in the abdomen.

GALL BLADDER—STOMACH ANASTOMOSIS

A Clinical and Experimental Study

By JOSEPH A. WEINBERG, M.Sc., M.D., STANLEY P. WALLIN, M.D., and MELVIN W. BINGER, M.D., Omaha, Nebraska

From the Department of Experimental Surgery, University of Nebraska College of Medicine.

THE operation of gall-bladder stomach anastomosis for relief of obstruction of the distal end of the common duct due especially to inflammatory conditions and carcinoma of the head of the pancreas has been accepted among surgeons for many years. The procedure is described in standard books on surgery. Some authors have gone to the extreme of recommending the procedure for relief of gastric ulcer with the idea of neutralizing the acid stomach secretion. No matter whether one does or does not consider the operation a good procedure, it must be admitted that occasions will arise when the surgeon has no choice but to use it. Such a case came to one of us (J. W.) about 3 years ago. Because we were very much concerned as to the possible derangement of the physiology of the gastro-intestinal tract, we made several tests to determine the presence of any changes from the normal. Fortunately the patient, who is a nurse, co-operated with us to the fullest extent.

Mrs. E. R., age 37, gave a history of having had a cholecystostomy performed 3 years previously for relief of gall-stone colic. Following this operation the gall-bladder fistula failed to remain closed because of obstruction of the common duct. On several occasions the fistula became closed for a period of 3 or 4 days. During these periods the patient was intensely jaundiced and suffered excruciating pain. With spontaneous opening of the fistula, the bile would again flow freely to the exterior with cessation of the pain and disappearance of the jaundice. An operation was performed with the intention of re-establishing the continuity of the common duct. However, on opening the abdomen there was found such a dense mass of adhesions that it was considered inadvisable to attempt to trace the duct. A gall-bladder stomach anastomosis was therefore performed. The patient made an uneventful recovery. Fifteen days after the operation an Ewald test meal was given and the contents recovered with a Rhefus tube. Tests of the acidity of the contents were made at 15 minute intervals and the results were as follows:

	15 min.	30 min.	45 min.	60 min.
Total acid....	20	30	36	14
Free acid.....	0	5	40	10

The laboratory technician reported bile present in all specimens except the first. A year after the anastomosis was performed the patient was again examined, and much to our surprise no bile could be recovered from the stomach with the same tests used just after the operation. We were forced to conclude that with the gall-bladder drainage into the stomach, the inflammation causing obstruction of the common duct subsided sufficiently to allow the bile to flow through its normal channel. It is well known that an artificial channel will not function if the norml channel is patent.

It will be seen that there was no demonstrable derangement in the reaction of the gastric secretion following this marked alteration of the anatomy and this is not surprising if we consider the manner in which bile normally flows into the intestinal tract. Normally little or no bile flows into the duodenum during the fasting period or in the early stage of stomach digestion. The flow of bile is started when the food first passes from the stomach into the duodenum, and reaches its maximum rate within a few minutes. Therefore it is only after stomach digestion is well advanced that bile will enter the intestinal tract. Apparently it is the passage of the food through the pyloric ring which stimulates the flow of bile. In anastomosing the gall bladder to the stomach nothing has been done to interfere with this sequence. Therefore bile should appear in the stomach only in the late phase of digestion.

In an attempt to answer some of the questions arising from a consideration of this operation, we performed experiments on several animals. The principal points considered were the effect of the anastomosis on the

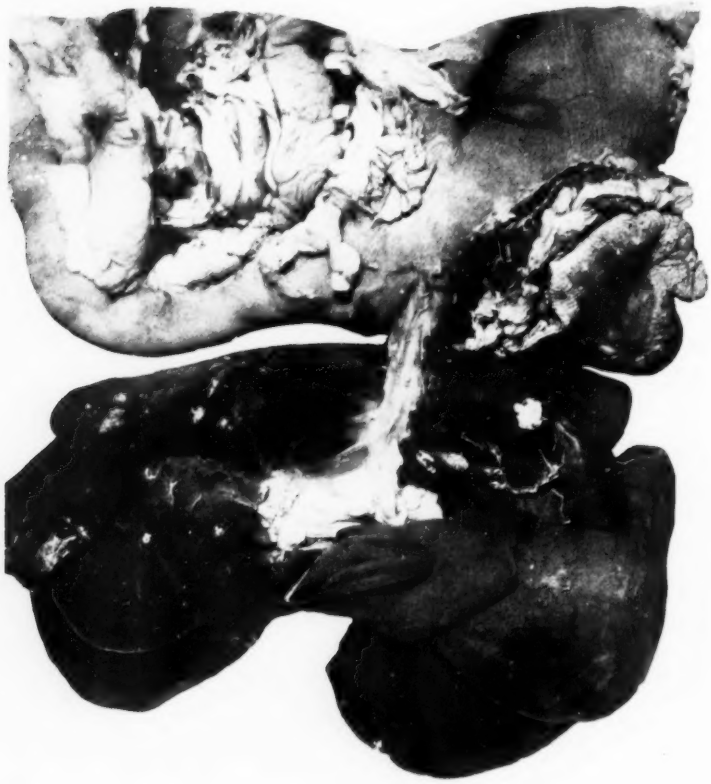

Fig. 1. The liver and stomach with the gall bladder connecting the two. The small white areas in the liver represent abscesses.

acidity of the stomach, the amount of bile present in the stomach during various phases of digestion, the effect on the emptying time of the stomach, and the incidence of gall-bladder and hepatic infection.

Our first investigations were made on dogs. The same technique was followed with each animal used. The common duct was severed and ligated. The gall bladder was attached to the anterior wall of the pylorus at a freely movable area, and a simple gastrostomy was made near the anastomosis to allow removal of samples of stomach contents. Several control dogs with simple gastrostomies were also prepared. A period of 6 weeks was allowed for complete healing of the tissues before the various tests were made.

We first made tests for bile in the fasting stomach. It was present in small amounts in 4 of 6 dogs, and was never present in the control dogs. This is what one would expect since there is normally a slight flow of bile during the fasting period.

During digestion bile was always present in dogs subjected to anastomosis. In several tests the bile flow was greatest 40 to 60 minutes after the introduction of food. In two tests the flow was greatest 60 to 75 minutes after digestion of food. To test for bile 10 cubic centimeters of stomach content were

mixed with ammonium sulphate powder and 2 cubic centimeters of acetone were added. After the acetone came to the surface a drop of concentrated nitric acid was allowed to flow down the side of the test tube. The presence of bile was indicated by a green color in the acetone. It is quite important to use an accurate method of determining the presence of bile, as color alone as a test is liable to lead one into error.

The emptying time was determined by introducing 300 cubic centimeters of gruel through the gastrostomy and withdrawing small specimens by means of a pipette until no more of the contents could be recovered. In the control dogs the stomach was empty at the end of 75 minutes. In the 3 dogs subjected to anastomosis there was a residue of approximately 50 cubic centimeters after 75 minutes; in 2 of these dogs the stomach was empty after 1 hour. The retention of 50 cubic centimeters in 3 of the dogs was probably due to a slight mechanical obstruction formed in making the anastomosis or gastrostomy.

The results of the tests for acidity showed little difference between the controls and the dogs subjected to operation, our findings in the case reported being thus confirmed. With 300 cubic centimeters of gruel as a test meal (gruel was used because of the ease of putting it into the stomach) the free acid was 0 to 5 degrees in the controls and 0 to 10 degrees in the dogs subjected to anastomosis. The total acidity was 15 to 35 degrees in the latter. There was apparently a slight decrease in acidity in late stomach digestion in the dogs operated upon, but this was not marked enough to warrant any conclusions.

In the few tests made for its determination, pepsin digestion was found impaired by the anastomosis. The Metz pepsin test with 24 hour incubation showed 1.2 to 1.5 millimeters digestion in 4 dogs. A control test showed 2 millimeters digestion. This observation is not of much value as only one control test was made.

All of the dogs gained in weight following operation. They seemed normal and in no way differed from normal dogs in their appearance.

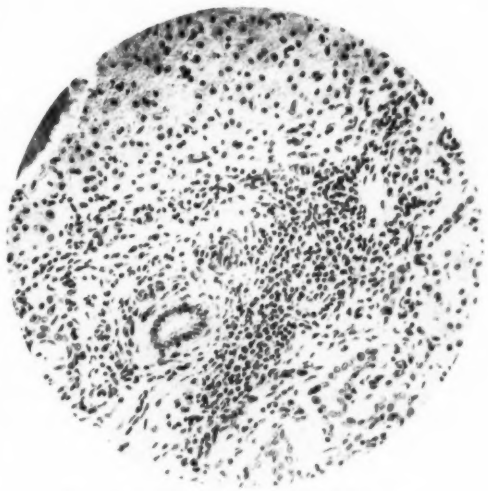

Fig. 2. The microscopic changes in the liver.

It is evident from these observations that the physiology of digestion in the animals was little disturbed. We have demonstrated that the bile is not appreciably mixed with the gastric juice at any time. The probable explanation of this failure of the two secretions to mix is that the bile while passing through the stomach follows a definite channel and therefore does not mix with the stomach secretion. That the bile does neutralize the acid secretion when the two are mixed was very definitely shown in the appearance of the skin next to the gastrostomy. In preparing the animals, the gastrostomy was made adjacent to the gall-bladder stomach anastomosis. In these dogs the skin adjacent to the gastrostomy remained normal, but in the control dogs the skin was strongly corroded by the action of the unaltered acid secretion.

After several months the dogs were killed and examination was made of the abdominal organs. The findings were uniform in showing inflammatory thickening of the gall bladder and numerous abscesses in the liver near the gall bladder. The occurrence of these abscesses in dogs following gall-bladder stomach anastomosis has been previously reported by Lehman and by Mann. If this result follows anastomosis in the human, the operation is of course not to be considered except in cases in

which bile flow from the liver to the gastrointestinal tract cannot be established in any other way (Fig. 1).

It was suggested by Dr. Eggers that possibly the difference in type of food particles found in the stomach of man and in the stomach of the dog might make a difference in the susceptibility to infection. In the dog the food consists of course particles which are not as extensively attacked by the bactericidal stomach secretion as the more finely divided food in the human stomach would be. We decided that the monkey, whose manner of digesting food rather closely resembles the human process, would be an ideal animal on which to test this supposition.

An anastomosis was accordingly made in a monkey in the same manner as that described for the dogs. The animal remained in good health for 8 months, and at the end of this period it was killed for examination of the gall bladder and liver. There was neither gross nor microscopic evidence of inflammation in the gall bladder. The liver showed no abscesses. The only evidence of pathology in the liver was a moderate fibrosis and lymphocytic infiltration around the portal radicals near the gall bladder. The photomicrograph is from an area showing the most marked degree of inflammation in the liver of the monkey.

It is possible that we have here an explanation of the discrepancy between the clinical and the experimental results. But the one experiment with the monkey is not sufficient evidence upon which to base a conclusion, and further investigation should be made in order to clear up this point.

OVARIAN PREGNANCY

By IRVING F. STEIN, M.D., F.A.C.S., and M. L. LEVENTHAL, M.D., Chicago
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ALMOST everyone who has written on ovarian pregnancy has attempted to analyze the literature on the subject; in consequence we have many divergent opinions as to the relative frequency of the condition. The latest to report such a case to date is Vineberg who from a study of the recent literature accepts 56 cases which he considers authentic up to September, 1926. This figure is at variance with that of Dorsch of Wuerzburg who collected 92 cases acceptable to him up to 1921. Sutton, on the other hand, claimed that only 48 cases were authentic up to July, 1924, including the one he reported. Whether any of these statistical studies represents the true status of ovarian pregnancy or not, all of the contributors agree at least that the condition is so rare and so interesting that each additional case observed should be recorded. Since Sutton's article at least 14 additional case reports have appeared in the literature indicating either that the condition is becoming more frequent or that the cases observed are being placed on record with greater regularity.

Webster's claim that the fertilized ovum can develop only on muellerian tissue has not been borne out by the experience of the past few years. The majority of observers believe that the ovarian gestation is usually found in a graafian follicle and not necessarily in muellerian tissue. In support of this view is the frequent presence of luetein cells in the walls of the ovarian hæmatomata. The presence of a true decidual reaction is not held necessary for the implantation of the ovum. That the ovum may also implant itself in the ovarian stroma independently of the graafian follicle is illustrated by Sutton in the 12 authentic cases considered by him representative of extrafollicular implantation of the ovum. The criteria upon which the diagnosis of ovarian pregnancy is based were outlined by Spiegelberg in 1878, and have been universally accepted. The case which we report below (exhibited before the Chicago Gyneco-

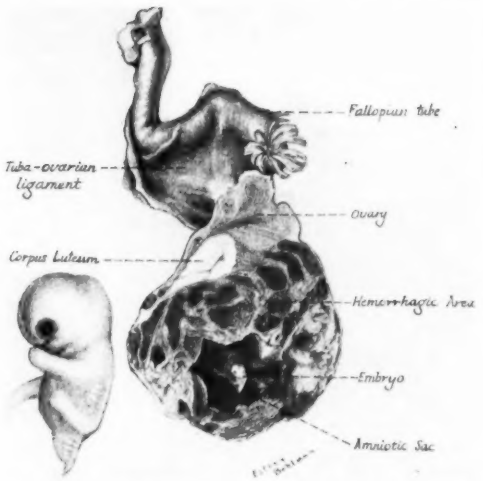

Fig. 1. Ovarian pregnancy. Drawing made from specimen in authors' case.

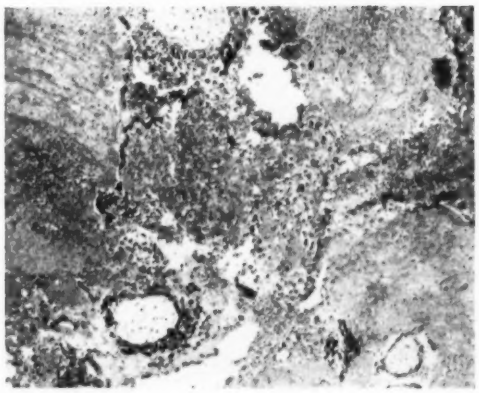

Fig. 2. Chorionic villi in ovarian pregnancy. Necrotic corpus luteum. ×60.

logical Society on February 18, 1927) answers all of the requirements of Spiegelberg's specifications, namely:

1. The tube on the side of the pregnancy must be intact.
2. The fetal sac must occupy the position of the ovary.
3. The ovary must be connected with the uterus by the utero-ovarian ligament.
4. Definite ovarian tissue must be found in the wall of the sac (in several places, according to Williams).
5. The embryo must be visible in the cavity of the gestation sac.
6. There must be placental tissue within the ovarian stroma.
7. The tube must not only be intact, but free from any evidence of gestation.

CASE REPORT

Mrs. M. J., age 29, married 7 years, had 3 children, the eldest 6 and the youngest 3 years of age. She had one induced abortion a year ago. She was admitted to the surgical service of Michael Reese Hospital with the diagnosis of acute appendicitis at 2 a.m. September 12, 1926. She walked into the hospital. The complaint was abdominal pain which had developed suddenly during the day, at first being diffuse over the whole abdomen and at the time of admission settling in the right lower quadrant. There was a history of nausea and vomiting with the onset of the attack. The admission temperature was 100 degrees F.; pulse, 98; respiration, 20; white blood count, 17,000.

Inquiry into the menstrual history revealed the fact that her last normal period was July 9, 1926. In August when the menstrual flow did not appear as expected she took emmenagogue pills after which she flowed scantily for about 2 weeks. The September period had not arrived at the time of her admission.

On the basis of this history coupled with the fact that the tenderness and rigidity were quite marked low down on the right side, the possibility of an ectopic pregnancy was considered, and one of us (Stein) was asked to see her in consultation.

At this examination, about 8 hours after her admission, the tenderness and rigidity of the lower abdomen and pelvis prohibited the palpation of the uterus and adnexa, and the probable presence of a low-grade postabortal pelvic infection was considered. The temperature was then 99.4 degrees F.; pulse, 29; white blood count, 12,200; hæmoglobin, 65 per cent; red blood cells, 3,300,000; and sedimentation time, 1 hour. Cervical smears were negative for gonococci. It was decided that the condition of the patient warranted expectant management in the hospital with close observation. Two days later when the rigidity disappeared a definite mass could be palpated to the right and posterior to the uterus, and the patient began to flow moderately, the bleeding continuing 5 days, simulating menstruation. She now complained of no pain. The hæmoglobin was 75 per cent; white blood count, 9,000; and sedimentation time, 55 minutes.

During the 2 weeks that the patient was kept in bed under observation, she apparently improved in every respect. Because of the persistence of the mass, however, laparotomy was performed September 25, 1926. A Pfannenstiel incision was made and when the peritoneal cavity was opened a quantity of dark blood was found. The pelvic

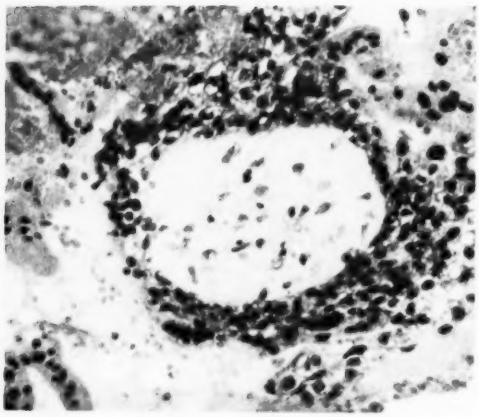

Fig. 3. Chorionic villus showing preservation syncytial and Langhans layers. ×230.

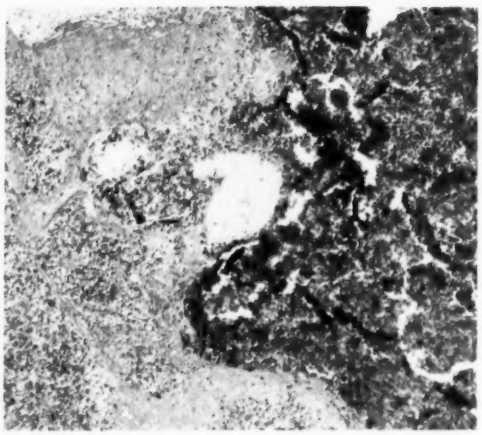

Fig. 4. Hæmorrhagic extravasation of ovary with degenerative changes manifest in the chorionic villi. ×75.

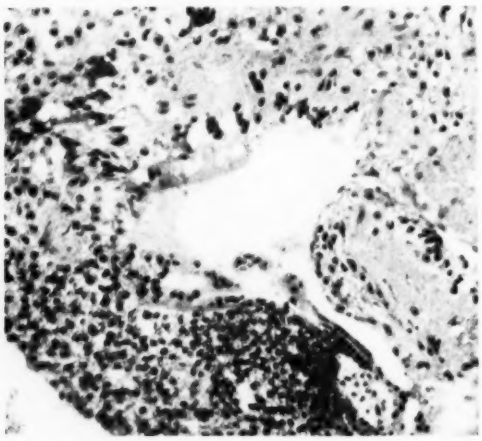

Fig. 5. Decidua-like cells. No true decidual reaction observed. ×150.

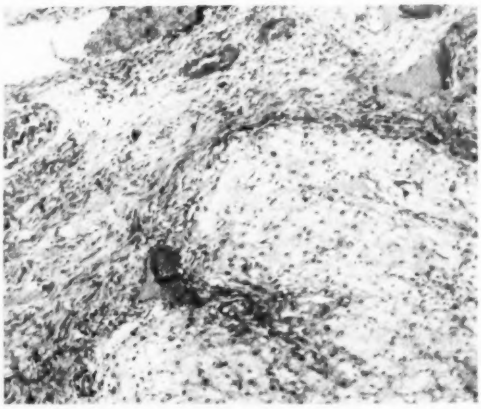

Fig. 6. Normal ovarian stroma and corpus luteum observed in the area between the gestation sac and tubo-ovarian attachment. ×75.

viscera were found completely buried by the densely adherent omentum and intestines. On the right side was a mass, dark in color, irregular in outline, about 6 centimeters in diameter, which appeared to arise from the right ovary. The tube was adherent to it but its fimbriated end was free. The opposite adnexâ were also surrounded by adhesions, so both were removed, the tubes being removed by wedge-shaped excision from the uterine cornuæ. Closure was effected without drainage.

The patient made a good recovery, complicated only by a stitch abscess in the fascial layer, which was relieved by drainage. She was discharged from the hospital in good condition 27 days after operation. The specimen (Fig. 1) is unquestionably an ovarian pregnancy. Grossly it consists of a fallopian tube, 7 centimeters in length, the fimbriated end of which is free. There is no marked tortuosity of the tube and there is no hæmorrhage in it. The cut section reveals a small lumen and a thick gray mucosa. Attached to it by a short, broad, thick ligament is a mass, 6.5 by 5 by 4 centimeters, of which the pole nearest to the tube is undoubtedly ovarian tissue. The outer surface of it is pale gray, firm, and coarsely corrugated. This merges into a large hæmorrhagic mass covered by a thin gray, smooth membrane. Section through this mass reveals a small, smoothly lined cavity, 2 centimeters in diameter, containing

a 10 millimeter fetus attached by a cord. The tissue surrounding this cavity is undoubtedly placental tissue containing a great deal of blood. Grossly it appears to be infarcted. At the border of this hæmorrhagic mass adjacent to the area of tissue which can be identified as ovary, there is a well defined recently formed corpus luteum, about 2.5 centimeters long and 1 centimeter wide. The cavity containing the fetus is eccentrically located and is separated from the margin farthest removed from the tube by 0.75 centimeter of placental tissue. The opposite border of the cavity is almost in the center of the mass.

Miscroscopic section. Sections through the ovarian mass in a region farthest removed from the normal ovarian tissue show that the mass is made up of numerous chorionic villi in most of which two cell layers can be made out (Figs. 2 and 3). These villi are embedded in and surrounded by a large amount of extravasated blood. The outer margin of the mass is formed by a fairly thick membrane in which there has occurred some older hæmorrhage in addition to the more recent one and has on the surface of it some necrosis and acute inflammatory exudate. Many of the villi are necrotic and have lost their cellular outline (Fig. 4). Scattered about are clumps of cells, the nuclei of which stain deeply and are eccentrically placed. The cytoplasm takes a faint eosin stain and is occasionally vacuolated. These cells are arranged more or less in a syncytial fashion and resemble decidual cells (Fig. 5); however, their arrangement in some fields indicates that they possibly may be fused cells which have been desquamated from the villi. In other areas they seem to be in the process of forming villi so that their resemblance to decidual cells is only that of their gross microscopic appearance. Section taken from the base of the tumor and the adjacent portion of normal ovarian tissue shows that the hæmorrhagic area is separated by a dense necrotic layer of cells which is richly infiltrated by leucocytes and is directly in contact with a thick layer of corpus luteum tissue composed of large pale staining polyhedral cells. The necrotic zone on closer examination is seen to be made up of corpus luteum cells. Beyond the corpus luteum, rather dense but normal ovarian stroma, containing a large number of blood vessels, can be seen (Fig. 6). A section through the fallopian tube shows no evidence of tubal pregnancy. None of the sections examined disclose any tissue resembling muellerian duct inclusions or so-called endometrial inclusions.

Five months have elapsed since the patient was operated upon. Examination at regular intervals has shown the patient to be in excellent condition.

REFERENCES

ACOMB and CANDY. Brit. M. J., 1926, i, 320.
BARNA, A. Zentralbl. f. Gynaek., 1925, xlix, 718.
BIERRING, K. Hosp.-Tid., 1922, lxv, 810.
BOWING, K. Monatschr. f. Geburtsh. u. Gynaek., 1923, lxii, 127.
BROOKS and CHARPIER. J. Am. M. Ass., 1923, lxxxi, 110.
BROUHA. Gynéc. et obst., 1923, viii, 335.
CHALFANT, S. A. Pennsylvania M. J., 1920, xxi, 548.
DAWSON, B. M. J. Australia, 1926, ii, 233.
FLETCHER and GALT. J. Obst. & Gynæc. Brit. Emp., 1923, xxxiii, 431.
FUCHS, H. Monatschr. f. Geburtsh. u. Gynaek., 1923, lxiii, 61.
GILMORE, SMITH and GATENBY. J. Obst. & Gynæc. Brit. Emp., 1925, xxxii, 339.
GOOD and RICHARDS. Surg., Gynec. & Obst., 1923, xxxvi, 239.
HORBUE, O. Zentralbl. f. Gynaek., 1923, xlvii, 2.
HUNTER, J. I. M. J. Australia, 1921, ii, 233.
JACOBS, J. Zentralbl. f. Gynaek., 1923, xlvii, 193.
KING, W. W. J. Obst. & Gynæc. Brit. Emp., 1926, xxxiii, 291.
KRAUSE, H. Ztschr. f. Geburtsh. u. Gynaek., 1924, lxxxvii, 390.
KUPFER, M. Zentralbl. f. Gynaek., 1925, xlix, 2241.
MANLEY, J. R. Am. J. Obst. & Gynec., 1926, xi, 512.
MARTEN and MCINTYRE. J. Obst. & Gynæc. Brit. Emp., 1923, xxx, 647.
MALL and CULLEN. Surg., Gynec. & Obst., 1913, xvii, 698.
MAYNE, R. M. J. Iowa M. Soc., 1926, xvi, 282.
MERTENS, H. Zentralbl. f. Gynaek., 1923, xlvii, 1737.
NICHOLSON and TAUZ. Semaña méd., 1924, ii, 1117.
NORRIS, C. C. Surg., Gynec. & Obst., 1909, ix, 123, 706.
NORRIS and MITCHELL. Surg., Gynec. & Obst., 1908, vi, 460.
RAY, H. M. Surg., Gynec. & Obst., 1921, xxxii, 437.
RENWELTS, R. Zentralbl. f. Gynaek., 1924, xlviii, 670.
ROBINSON, A. L. J. Obst. & Gynæc. Brit. Emp., 1924, xxxi, 410.
SFAKIANAKIS, J. Klin. Wchnschr., 1923, ii, 882.
STEINWEG, P. Ztschr. f. Geburtsh. u. Gynaek., 1926, lxxxix, 380.
SURANSA, S. Lancet, 1924, i, 648.
SUTTON, L. A. Am. J. Obst. & Gynec., 1924, vii, 1.
THOREK, M. Illinois M. J., 1926, xlix, 106.
VINEBERG, H. N. Am. J. Obst. & Gynec., 1926, xii, 332.
WEBSTER, J. C. Surg., Gynec. & Obst., 1907, v, 240, 483.
WILLIAMSON, G. M. J.-Lancet, 1925, xlv, 463.

PRIMARY ABDOMINAL PREGNANCY

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THE origin of abdominal pregnancies has long given rise to speculation. We know that, in some instances at least, the ovum appears to be fertilized *in situ*, for this is the most reasonable and likely explanation of ovarian pregnancies, of which a number of indisputable cases are on record. But this further question arises: Are abdominal pregnancies outside the ovary always secondary in nature; that is, has the ovum developed to a certain extent in the tube and subsequently by tubal abortion or rupture been shed into the abdominal cavity, settled down where it fell and, aided possibly by the blood clot accompanying it, proceeded to develop *in situ?* Or is there such a thing as a true abdominal pregnancy in which the fertilized ovum, without residence in the tube or ovary to promote its start, settles down and develops for itself unaided by the presence of any surface into which it can readily sink?

A considerable number of cases are now on record which seem to support the hypothesis of primary abdominal pregnancy. Apparently the first of these was Galabin's case, reported in 1896. While there seems a possibility in this case that a very early tubal abortion may have occurred, a careful study of the autopsy specimens by a committee of the Obstetrical Society of London resulted in a diagnosis of primary abdominal pregnancy. In Witthauer's case, published in 1903, the ovum was rolled up in a piece of omentum which was adherent to the pelvic organs. Hirst and Knipe, in 1908, published a case which seems to meet all requirements. The case reported by Hammacher in 1910 is similar in many respects to the one we describe below. Other apparently genuine cases of primary abdominal pregnancy have been reported by Richter, Czyzewics, Kohler, and quite recently by Poten and by Mayer. In 1922, Jacquin of the Clinique d'Accouchement et de Gynécologie de Strasbourg gave an excellent review of the literature and cases up to that time. He admits the cases of Richter, Czyzewics, Kohler, and Walker as genuine and adds two more of his own and one seen by Schickele.

While the evidence submitted in these cases seems to be convincing, there are some authors who still question the existence of this condition. Thus, Schumann in his monograph on *Extra-Uterine Pregnancy*, published in 1921, speaks as follows: "No really authentic case of this variety which has withstood all criticism has been recorded." Veit, in 1903, reviewed the whole subject at the Congres de Gynécologie de Wurtsbourg and came to the conclusion that exact proof of its occurrence had not been satisfactorily demonstrated. (Only two of the more questionable cases were then on record.) He subsequently revised his opinion somewhat, and laid down certain very stringent criteria.

We believe that the following case is a true example of primary abdominal pregnancy. It not only fulfills the desiderata usually required, but seems to present certain anatomical peculiarities which make it particularly convincing.

Hosp. No. 15862, a Chinese housewife, 32, married, admitted to the Peking Union Medical College Hospital January 21, 1927. She gave a history of five pregnancies, the fourth being an abortion at 3 months. The other pregnancies all came to term, and the children are alive and well. The last labor had been 16 months before; and she was still suckling the child. Four weeks ago she had a scanty menstrual period and 2 weeks ago a very slight bleeding. At 9:30 a.m. on the day previous to admission she was seized with sudden intense pain in the lower abdomen, left side. Brandy gave some relief, but the pain was still severe enough to keep her in bed. At 4:30 p.m. she had another intense attack

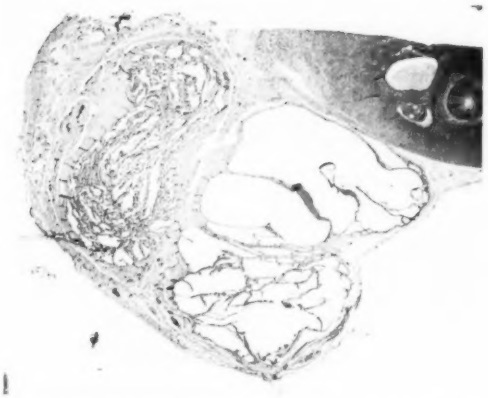

Fig. 1. Fimbriated extremity of the left tube closed by adhesions and cystic. × 5.

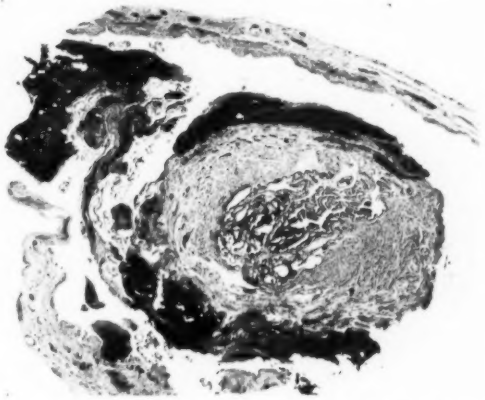

Fig. 2. Section of tube and conception showing chorionic villi, blood clot and intact tube lumen. × 8.

of pain, collapsed, and was taken to the Presbyterian Hospital.

At 7:30 p.m. consultation was sought from the Peking Union Medical College Hospital. The patient was then restless, gasping for breath, and complaining of inability of vision. Blood pressure was about 50 systolic, and she was pulseless, and blanched. Since she appeared moribund, it was thought best to do nothing in the way of radical treatment until she recovered from the profound shock. Seen at 8 a.m. on the next morning, the patient appeared slightly improved, though still pulseless and blanched. The blood pressure was 50-60 systolic, and very difficult to determine, though respiration was fairly regular and the patient conscious. An injection of morphine was given, and she was transferred to the College Hospital by ambulance.

At 12 noon the patient was taken to the operating theater still pulseless, with blood pressure about 60 systolic. Direct blood transfusion was begun by the syringe method, and the abdomen opened. A large amount of clotted and fluid blood was found. The left tube was lying in normal position with a rupture on its superior surface about half way from the cornu to the fimbriated extremity, which was, however, manifestly sealed, and had apparently been so for a long time. There was no sign of recent inflammation about this portion of the tube, and the left ovary was normal. The ruptured portion projected markedly from the surface of the tube, which seemed to be affected over a smaller area than is usual. The reason for this was later made clear by the microscopical examination. The right ovary and tube were in place, and in the distal portion of the ovary from the fimbriated extremity of the right tube there was a typical corpus luteum of pregnancy. The right tube was perfectly normal, both as to size, shape, palpation and color, and the fimbriated extremity showed no signs of inflammation either past or present. The left tube and ovary were quickly removed, the abdomen sponged out and closed, and the patient left the table with a perceptible pulse at the wrist, 600 cubic centimeters of whole blood having been given.

Recovery was rapid and complete, and the patient went home on the fourteenth day after the operation.

The Report of the Pathological Department on the Specimen is as follows:

Gross examination. Specimen consists of a fallopian tube and ovary. The distal end of the tube is closed up and bound down to the surface of the ovary. There is a cyst in the ovarian ligament, the wall of which is very thin. The lumen contains colorless fluid. In the middle portion of the tube is an area which shows a reddish brown discoloration. The wall of the tube is broken at this part and the lumen is slightly distended and contains loose grayish brown material. Sections of the tube cut distally from this hæmorrhagic area show that the lumen is closed up by grayish white solid tissue. There are several small cysts in the ovary.

Second specimen consists of an irregularly shaped piece of tissue, consisting of small villi. This material had probably dropped out from the lumen of the tube.

Microscopic examination. The fimbriated end of the tube is sealed up by old adhesions, and its epithelial lining forms several cysts which contain coagulated fluid. The lumen of the middle portion of the tube is very narrow and almost obliterated, its villi being bound together by old adhesions. Decidua and chorionic villi are found on the peritoneal surface of the tube, especially in a pocket formed by the mesosalpinx and the mesovarium. This pocket was taken for the lumen of the tube which was described in gross as being broken. The loose tissue described in gross was situated in this pocket and represents chorionic villi and decidua. The lumen of the tube does not communicate with the sac although at one

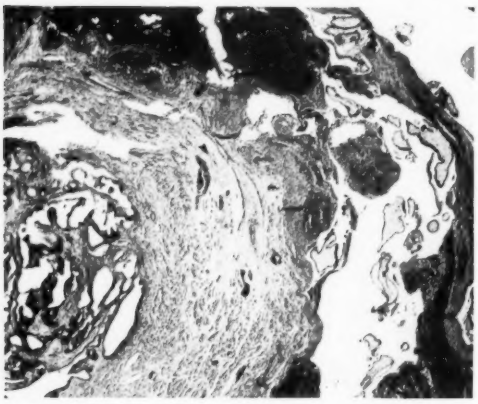

Fig. 3. Section of tube and part of conception showing chorionic villi, blood clot wall, and lumen of tube. × 21½.

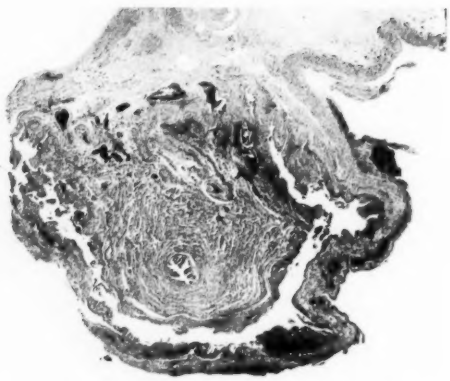

Fig. 4. Section of tube and part of conception showing the pocket formed by the mesosalpinx and mesovarium. × 8.

point the placental tissue is dissecting the wall of the tube and is found in close neighbourhood to the mucosa of the fallopian tube. Nowhere is there decidua found in the mucosa of the tube. There are several follicle cysts in the ovary. An organizing corpus luteum was found in the ovary.

Diagnosis. Chronic salpingitis with obliteration of fimbriated end of fallopian tube; ectopic pregnancy, formation of decidua and chorionic villi on the peritoneal surface of fallopian tube and in a pocket formed by the mesosalpinx and mesovarium; follicle cysts in ovary, organizing corpus luteum in ovary.

There were no signs about either tube or in the pelvis of the presence of endometriomata which might serve as a nidus for the ovum to occupy, and it is at least unlikely that there was only one such nidus situated on the outer surface of the tube. The corpus luteum found in the left ovary was one belonging to a previous ovulation, and was in a state of marked degeneration, while there was no doubt whatever about the corpus luteum of pregnancy in the right ovary, which was normal in appearance. Apparently the ovum having been fertilized in the abdomen, and having failed to enter the only normal tube, the right one, wandered over to the left of the abdomen and failing to enter the left tube, on account of its closed fimbriated extremity, settled down on the outer surface of the tube and proceeded to embed itself. The sections, of which many have been made, show clearly that the lumen of the tube is intact, and that the ovum has embedded itself from without the tube. There is only one similar, or possibly similar, case which we have found on record, namely, one by Hammacher, the place of attachment being the peritoneal surface of the right tube.

BIBLIOGRAPHY

BLAND-SUTTON, JOHN. The Purvis oration on abdominal pregnancy in women, cats, dogs, and rabbits. Lancet, Lond., 1904, ii, 1625–27.

CZYZEWICZ. Die Bauchhoehlenschwangerschaft im Lichte, neuer Beobachtung. Arch. f. Gynaek., 1912, xcvii, No. 1.

GALABIN, ALFRED L. Brit. M. J., 1903, i, 664–65; also Tr. Obst. Soc., Lond., 1896, xxxviii, 38–40.

HAMMACHER, J. F. M. Ein Fall von Peritonealgraviditaet. Arch. f. Gynaek., 1910, xcii, 594–605.

HIRST, B. C., and KNIPE, N. Primary implantation of an ovum in the pelvic peritoneum. Surg., Gynec. & Obst., 1908, vii, 456–459.

JACQUIN, P. La Grossesse abdominale primitive. Gynéc. et obst., 1922, 492–512.

KOEHLER, HERMANN. Primaere Abdominalgraviditaet. Monatschr. f. Geburtsh. u. Gynaek., vol. xlviii, 83–97.

MEYER, JULIUS. Ein Fall von primaerer Abdominalgraviditaet. Zentralbl. f. Gynaek., 1925, xlix, 118–122.

POTEN, W. Ein echte Peritonealschwangerschaft. Arch. f. Gynaek., 1924, cxxii, 134–41.

RICHTER. Die primaere Abdominalgraviditaet. Arch. f. Gynaek., 1912, xcvi, No. 3.

SCHUMANN, EDWARD ARMIN. Extra-uterine pregnancy. New York: Appleton & Co., 1921, p. 26.

VEIT. Congr. de gynéc. de Wuertsbourg, 1903, p. 45.

WALKER, J. Ein Fall von primaerer Abdominalschwangerschaft. Arch. f. Gynaek., 1919, cxi, 342–69.

WILLIAMS, J. WHITRIDGE. Obstetrics. New York: Appleton & Co., 1923, p. 738.

WITTHAUER, KURT. Zentralblatt f. Gynaek., 1903, xxvii, 136–41.

CLINICAL SURGERY

FROM THE OBSTETRIC CLINIC OF DR. BARTON COOKE HIRST

THE BARTON OBSTETRIC FORCEPS

A Review of Its Use in Fifty-Five Cases

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TRANSVERSE and posterior arrests of the head high in the pelvis have been perennial obstetric problems and their management a never ending source of discussion. That the mechanism of labor involved in these conditions is interpreted in hopelessly divergent ways, is evidenced by the varying degrees of importance accorded the conditions as pathological or clinical problems in different localities, and the ofttimes acrimonious disagreement among proponents of various methods of delivery. Among those whose training or preference is in favor of forceps interference in suitable cases after reasonable test of labor, the two problems are frequently considered together. Here again, the conception of the primary fault, whether of rotation or descent, is mooted, advocates of various manœuvers differing as to the proper sequence for applying traction and rotation. For persistent posterior positions of the vertex, this clinic has, for many years advocated and continues to recommend, the Scanzoni manœuver with rotation deferred until the biparietal diameter has passed the bony outlet, whatever the level of the original arrest—excepting those cases in which rotation has a tendency to occur spontaneously as traction completes the descent. For transverse arrests, however, particularly at the pelvic brim, there has long been need of a more suitable instrument than the classic forceps, especially in those instances in which effort has been made without success to alter the position manually into an oblique lie before applying the forceps. An instrument with diminished or absent pelvic curve is here desirable—and the Elliott blade has in some clinics been utilized, even to the extent of manually changing all posterior arrests into transverse positions (4)—thus to apply the forceps and complete delivery without the reapplication imposed by the Scanzoni technique. However frequently the need has been felt and means devised, no practical solution has attracted the widespread attention achieved by Kjelland's instrument in the past decade abroad, and more recently in this country (1, 2, 3). With the enthusiasm attending its successful trial in the transverse arrests for which it was presumably designed, it has been used and recommended on more numerous indications, judiciously or otherwise, in face, and even breech presentation. It is also recommended now for direct application to posterior as well as to transverse arrest.

To American obstetricians it should be of interest that an instrument was devised simultaneously and independently in this country by Dr. Lyman Barton, of Plattsburgh, New York, which circumstances prevented having the early and extensive trial enjoyed by Kjelland's idea, but which from an experience in 55 applications in this clinic since April, 1925, impresses us more favorably in its design and in its actual use. The Barton forceps differs from the classic types in that the blades join the shanks at an angle corresponding with that between the axis of the superior strait of the pelvis and the axis of the pelvic outlet. For purposes of application a joint is incorporated at the junction of the anterior blade with its shank, permitting the blade to be swung through an arc of a circle until it is nearly parallel with the shank. The limits of this arc of 90 degrees are controlled by a shoulder which automatically keeps the blade rigidly immovable on the shank when the instrument is applied. Like the Kjelland forceps, the instrument is provided with a sliding lock, but it is lighter in construction. Figure 1 shows a comparison of the two instruments drawn to scale. It will be noted from the drawings that there is no pelvic curve in the Barton blades (*c1*). Lightness of construction, together with absolute flatness of the cephalic

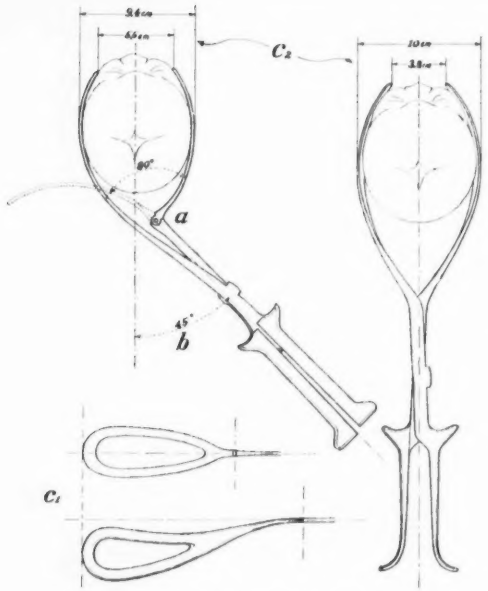

Fig. 1. Drawing of instruments drawn to scale.

surface of the blades, and absence of "cupping" in the cephalic curves, permits an overall diameter of 9.4 centimeters as compared to 10 centimeters with the Kjelland blades applied to the same fetal skull having a biparietal diameter of 9 centimeters (*c2*). The shape of the cephalic curves, moreover, provides for a more snugly fitting application to the same head in the case of the Barton blades, with wide separation of the blade tips (*c2*), more evenly distributed pressure over the cranium, and less forceps "flare" in advance of the descending head.

Extracts from a letter by Dr. Barton should be historically interesting:

"The purpose for which the instrument was invented was to construct a forceps that would be applicable to the biparietal diameter of the head in cases of arrest of the head at the pelvic brim, without disturbing the relation of the head to the pelvic axis. I never saw or heard of the Kjelland forceps until several years after my drawings were made so I can scarcely say that they were designed as an improvement on that instrument . . . . As to original dates I would say that the idea of constructing a forcep with the blades at an angle to the shanks occurred to me over 20 years ago. A rather crude model was constructed and I had a conference with the late Professor Cragin, of Columbia University, in regard to this modification of the forcep. His opinion was that while the idea might be correct in theory it would not work out in actual practice. Acting on his advice I did nothing further with the forceps until 14 years ago. At that time I had drawings of the perfected instrument and these were given to Professor Studdiford for his opinion. He agreed with Professor Cragin and consequently the project was again abandoned. In 1924, I exhibited a drawing of the forceps to Doctor A. D. Campbell, of Montreal, who at once grasped the significance of the design and advised me to have the forceps made at once. The first pair was completed about the middle of October, 1924, and Professor Studdiford had, in some way, heard of it and asked me to show the forceps to him as soon as completed. During the Clinical Congress of the American College of Surgeons held in New York City in October, 1924, I exhibited them to both Professor Studdiford and Doctor Caldwell. Both were very skeptical as to their value, but finally to settle the question, they decided to see what could be accomplished with the manikin. Doctor Caldwell was the first to experiment with them and much to his surprise he found they were easy to apply and effective in delivery. The first actual case in which they were used was during the first week of December, 1924. They were exhibited at Sloane Maternity at a meeting of the American Gynæcological Club in February, 1925. At that time I think they had been used in fourteen difficult cases. I have not heard from Doctor Caldwell in regard to their use at Sloane since December, 1926. At that time there had been 106 cases at that institution."

The following technique of application is recommended for deep transverse positions:

With the patient in the dorsal position, under anæsthesia, the operator should first make an exact diagnosis of the level of the presenting part, the direction of the sagittal suture in relation to the pelvic diameters, and the position of the fontanels. It will aid the beginner to visualize the desired application if the two parts of the forceps are articulated and the instrument held in front of the perineum. For all applications the blades will naturally be in a line perpendicular to the sagittal suture, and the hinged blade always uppermost. Note is made of the side on which the leading point (occiput in vertex, chin in face presentations) lies, in order to know in which direction to rotate the head when the proper moment arrives.

Either the anterior or posterior blade may be introduced first, but to avoid crossing the handles it is preferable to start with the anterior or hinged blade. It is likewise of little importance which hand is used to introduce the blade; following the custom of most users of the Kjelland forceps, the left hand is recommended as the "vaginal hand" for both blades. The index and middle fingers of the left hand are therefore introduced into the vagina, and the posterior rim of the cervix sought. The handle of the anterior branch is then grasped lightly with the right hand, and with the concavity of the blade directed toward the ceiling, the blade is guided up the posterior wall of the vagina until the tip lies against the head in front of the promontory and within the rim of the cervix (Fig. 2). Rotation is then accomplished

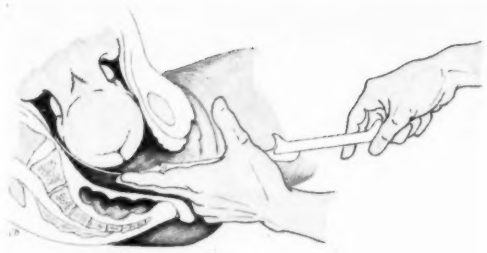

Fig. 2. Figures 2 to 12 illustrate the steps in the application of the forceps.

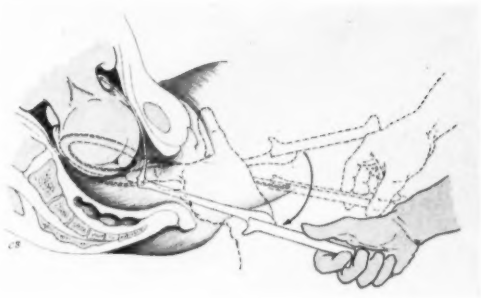

Fig. 3.

with the fingers of the internal hand aided by gentle torsion of the handle in the right hand (Fig. 3). Here, again, it is of little importance to which side the blade is rotated, whether over the occiput or across the face, but we prefer always to attempt it first over the occiput, and in most cases this is readily achieved. There are instances, however, in which excessive molding of the occiput will make it easier to rotate across the face, and this may be attempted without fear of inflicting injury if the operator is reminded that in this, as in any forceps application, force is dangerous and should be unnecessary if the case be properly chosen. In occasional cases there will be temptation and perhaps justification for displacing the head slightly up out of the pelvis in order to complete an otherwise difficult application, but the danger of prolapse of the cord is as imminent here as with any instrument, and the practice is not to be encouraged. It will aid in understanding the technique of rotation to appreciate that the arc described does not necessarily pivot around the hinge joint as a fixed point; the latter usually describes a coincident but smaller arc in an opposite direction, as illustrated, the pivotal center being a short distance within the blade itself. The blade can also be coaxed gently around when necessary, by altering the depth of its introduction. At the completion of this stage of the technique, the anterior blade will be along the biparietal line of the head just back of the symphysis, in the vertical plane.

The second blade of the forceps is likewise introduced posteriorly, and because of the construction of the lock, always to the operator's left side of the first blade. The index and middle fingers of the left hand, without withdrawal, again seek the posterior margin of the cervix, and with the right hand used to introduce this branch of the instrument posteriorly, the internal fingers guide the blade into place (Fig. 4). By raising or lowering the handle of this branch, the blade will slide readily into place, escaping impingement upon the promontory. With heads of normal biparietal diameter, and in synclytism, the handles should lock exactly. Separation of the handles usually means an increased biparietal diameter, while lack of apposition in the longitudinal axis of the handles as a rule denotes either a small or asynclytic head. Effort should be made to determine the latter point as well as the maintenance of the original transverse relation of the sagittal suture before withdrawing the internal fingers. When the head is asynclytic, the application may be altered to meet the condition by raising or lowering the handles. Because of the sliding lock, however, the branches may be articulated even though the blades are not on the same level, and with the first traction the blades will adjust themselves.

With the forceps symmetrically in place over the parietal bones of a transverse head, the blades are in the anteroposterior diameter. In occasional instances of tight engagement it may be justifiable to alter this exact application by placing the posterior blade slightly to that side of the promontory on which the leading point lies, and adjusting the anterior blade to fit opposite; cases have been delivered thus when no other forceps manœuver was possible.

Before beginning traction, it will be noted that the handles point forward and downward, not in an axis continuous with the vertical or sagittal axis of the head, but at an angle deviating approximately 45 degrees forward from this line (Fig. 5). Traction therefore is *not* made in the direction of the handles, but in the axis of the child's head, or more strictly, in the axis of the pelvic canal at the level of the greatest diameter of the presenting part. The force applied is, therefore, translated. It is made entirely with one hand grasping the shanks of the forceps firmly

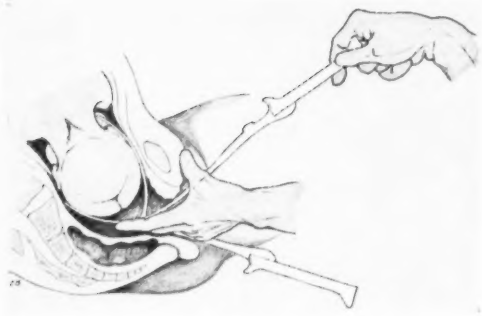

Fig. 4.

near the hinge joint, as shown. As an aid to this step, an axis-traction handle has recently been devised for attachment to the shanks. The other hand grasps the handles proper, but very lightly and only to maintain apposition and to aid in guiding the forceps. The traction may be applied either by pulling, or by standing to one side of the forceps just within the maternal thigh, and pushing downward and forward in the required direction (Fig. 6). Tremendous power can be developed by the latter method, a fact of interest to those who may be skeptical of the adaptability of so light an instrument for difficult tractions. As the head descends, there is a tendency to spontaneous rotation, which should be followed and encouraged by altering the position of the handles to maintain the application in fixed relation to the scalp as it appears (Fig. 8). In cases in which spontaneous rotation does not occur, the practice in this clinic is to bring the head to the outlet before attempting rotation; crowning of the scalp is usually well advanced at this point, and if the direction of the pelvic canal has been properly

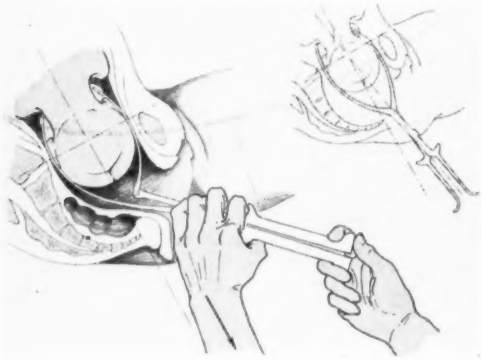

Fig. 5.

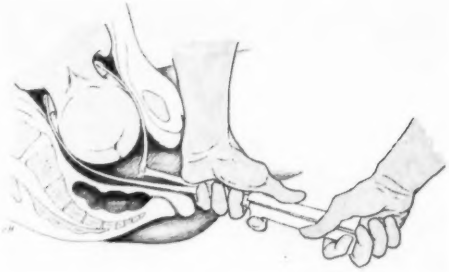

Fig. 6.

followed, the forceps handles will be slightly elevated. The elevation is not so great, for corresponding levels of the birth canal, as with the classic forceps, and caution must be exercised, as with the Kjelland instrument, not to lift the handles prematurely, because of the danger of injuring the cheek or facial nerve with the anterior blade. During rotation of the head, traction is greatly lessened but need not and should not be abandoned entirely. As the head rotates, the handles will tend to swing upward and laterally over one or the other maternal thigh, but the coincident extension and transit of the head through the vulvar orifice raises the blades simultaneously, the terminal movement of the instrument thus being an upward roll in the so-called curve of Carus, and the final position one of almost complete inversion with the handles inclined upward and transversely across a thigh (Fig. 9; see also Figures 10, 11, and 12).

While the teaching and practice of this clinic has long favored the Scanzoni manœuver for persistent posterior positions of the vertex, the above technique for Barton application in transverse positions is equally applicable to posterior positions, with the few obvious alterations necessary to bring the blades to grip on an oblique head biparietally, and the extra degrees of rotation necessary to guide the leading point under the symphysis. Extraction is completed without re-application.

Our series includes the use of the Barton forceps in 55 cases during the past 2 years, in a total of approximately 900 in-patient deliveries at University Hospital. The applications were made by five members of the staff. The use of the Kjelland forceps in only 12 cases in the same period means that preference was given the Barton forceps when either forceps was indicated, with the purpose of using the Kjelland instrument in just enough cases to reach some impression or judgment as to comparative values. The validity

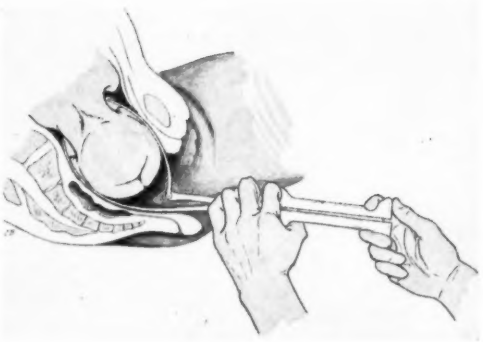

Fig. 7.

Fig. 8.

of the indications for forceps interference is attested in part by the average duration of labor for the series, the same being over 24 hours, including 6 elective applications and 33 multiparous labors. The forceps was, therefore, subjected at once to the same tests and obstacles confronting any forceps maneuver, there being 28 high applications, and the group in any event not being a selected one. Note should also be made of the local practice of deliberately incurring "errors of judgment" by attempting a trial forceps in all cases admitted from outside sources with obstructed labor or floating head (when the disproportion is not too obvious and when the cases are potentially or actually infected from manipulations prior to admission), the above being in many instances a routine preliminary to a patently indicated cæsarean section or craniotomy.

The results are tabulated under two classifications, applications to transverse (Table I) and to oblique positions (Table II), to form some idea of the usefulness of the instrument in conditions other than that for which it was strictly designed, and to compare it with both the classic and the Kjelland forceps in these instances. In each table the applications are listed as to "arrests," "floating heads" and "elective" applications, meaning simply the position and explanation therefore at the time of application. In case of transverse arrests, it is impossible to analyze the labor further as to the primary positions, some cases, therefore, being transverse arrests of rotation from original posterior lies, and others being arrests of descent from original transverse engagements in flat pelves. A low transverse or posterior arrest is arbitrarily regarded as nonexistent and, therefore, is not listed. Simple Barton rotations without extractions are listed separately, but nevertheless as "successful forceps," along with the complete maneuver, since in all the former instances the extractions were completed by classic forceps from choice rather than necessity. Failures are catalogued as "failed applications" and "failed forceps" after successful applications. The failures are more illuminating than the successes, and several facts immediately are made clear.

The first is that despite the ultimate outcome and the bad obstetrics involved, the Barton forceps is adaptable to floating heads, there being one failure in ten attempted applications.

For *transverse* applications we believe the instrument to be the safest and best designed forceps yet devised. The two failures of application in this group were both errors of technique due to inexperience, one involving a prolapsed cord in a case of hydramnios with accidental displacement of the head during placement of the anterior blade. The latter accident is a more likely event with the Kjelland forceps, since disengagement of high heads is almost a necessity to permit introduction of the anterior Kjelland blade into the uterine cavity and its rotation therein.

Fig. 9.

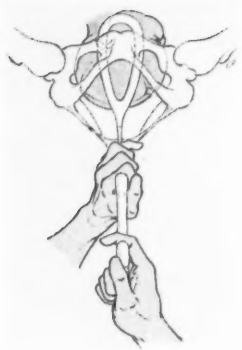

Fig. 10.

Fig. 11.

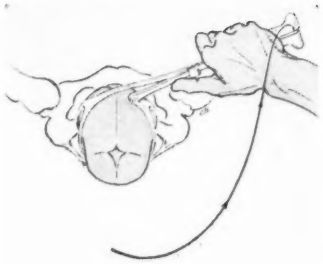

Fig. 12.

The light construction of the Barton blades, and the "wandering" technique of application of the anterior blade make it not only a safer instrument than other types of forceps, but widen its range of usefulness in borderline misfits and disproportions. The only unusual maternal injury of note in primiparous labors in the transverse group was a transient vesicovaginal fistula in a borderline case with a floating head. With the forceps once applied, failure of Barton delivery was met in 3 cases out of the 34, in 2 of which the application was made with a certain prospect of failure, craniotomy being necessary in one and cæsarean section in the other. The remaining case, delivered by classic forceps, might have been managed with the Barton forceps after further familiarity. But taking inexperience and other conditions into account, the facts are demonstrated that, once applied, the new instrument was successful in every instance open to forceps except one, and that only one case in the series was delivered by other forceps after failure of the Barton forceps. The angulation permits traction in the true axis of the inlet (Fig. 5) without interference with the pelvic floor or perineum, and without soiling of the operator's hands by contact with the anal region. With the Kjelland forceps, episiotomy is sometimes required to permit downward traction, and contamination at the anus is difficult to avoid. This advantage of angulation is partly offset by the fact that the force applied must be translated, requiring an accurate knowledge of the forces of labor. Caution, moreover, is required to avoid too early elevation of the handles, and consequent facial injury by the anterior blade—a fault, however, applying equally to the Kjelland forceps. Although extraction of the head is readily accomplished with the Barton forceps, it is not as suitable for "scooping the head out" as an instrument with a pelvic curve. Even in this particular, however, we regard the more snugly fitting Barton blade as superior to the Kjelland, with the latter's wide cephalic curve interposing considerable forceps flare and bulk in advance of the descending and emerging head and subjecting the soft parts to undue distention and strain.

A greater percentage of "failed forceps" occurred where the Barton forceps was used on *oblique* heads, there being 5 such in 19 applications, with 2 additional "failed applications." Three of the 5 failures were "errors of judgment" in that the cases were unsuited for any forceps. In spite of a local preference for the Scanzoni maneuver in persistent posterior occiputs, the instrument was successfully used in 3 cases of occiput in the hollow of the sacrum, showing that it is at least practicable in this ultimate expression of failed rotation.

SUMMARY

From an initial experience with the Barton forceps, we believe that there is a definite, though limited, field of usefulness for this instrument, particularly in the rotation and traction of transverse arrests of the vertex in high and mid pelvis. It is the safest implement yet devised for these purposes, and in some instances of impaction provides the only suitable or possible management. While its use in floating heads is not to be encouraged, its adaptability to this problem is unquestioned, and it will thus serve to increase the number of deliveries *per vias naturales* in these as well as in borderline disproportions. It has certain advantages over other instruments designed for the same purposes, notably the Kjelland. It can be used to complete the extraction of the head, and it can be applied to oblique

TABLE I. BARTON FORCEPS TO TRANSVERSE POSITIONS

Key		1	2	3	4	5	6	7	8	9	10	11	12	13	14
										Successes			Failures		
		Total	Primiparæ	Multiparæ	Deformed pelvis	Disproportion	Previous dystocia	Average length labor in hours	Failed classic forceps	Rotation and extraction	Rotation only	Total successes	Failed application	Failed forceps	Total failures
A	High Arrests	10	4	6	5	3	3	26	1	7	2	9		1	1
B	Mid Arrests	17	9	8	2	1	3	29	2	10	5	15	1	1	2
C	Floating Heads	4	1	3	2	2	2	34	2	2		2	1	1	2
D	Elective	3	1	2				24	1	3		3			
	Total cases	34	15	19	9	6	8	28	6	22	7	29	2	3	5

Presentations

Vertex	32
Military (A10)	1
Vertex and hand (B9)	1

Indications for Application

Arrests—Time: Occiput persisting transverse	20
Military, transverse	1
Deformed pelvis, occiput transverse	2
Compound presentation	1
Inertia	3
Floating heads—Time	4
Elective—Placenta prævia	1
Placenta prævia and twins	1
Demonstration to students	1

TABLE II. BARTON FORCEPS TO OBLIQUE POSITIONS

Posterior occiput

Key		1	2	3	4	5	6	7	8	9	10	11	12	13	14
										Successes			Failures		
		Total	Primiparæ	Multiparæ	Deformed pelvis	Disproportion	Previous dystocia	Average length labor in hours	Failed classic forceps	Rotation and extraction	Rotation only	Total successes	Failed application	Failed forceps	Total failures
E	High Arrests	3	1	2			2	12	1	1	1	2		1	1
F	Mid Arrests	6	3	3			2	27	2	3	1	4	1	1	2
G	Floating Heads	6	2	4	2	3	2	32		1	3	4		2	2
H	Elective	3		3				13		3		3			
	Anterior occiput														
I	Mid Arrests	2	1	1	1	1	1	30			1	1	1		1
J	Floating Heads	1		1	1		1	36						1	1
	Total cases	21	7	14	4	4	8	25	3	8	6	14	2	5	7

Presentations

Vertex	20
Vertex and hand (G9)	1

Indications for Application

Arrests—Time: Occiput persisting posterior	2
Rigid soft parts	1
Inertia	4
Occiput in hollow of sacrum	3
Disproportion	1
Floating heads—Time	5
Compound presentation	1
Inertia	1
Elective—Abruptio placentæ	1
First of twins	1
Demonstration to students	1

as well as to transverse positions, but, although superior to the Kjelland in both respects, it is inferior to the classic forceps with full pelvic curves. Its chief advantage from the standpoint of design, the angulation of the blades, is also its chief disadvantage in unskilled hands, requiring a more accurate knowledge of the mechanism of labor to develop the proper direction of traction, and to avoid facial injury with the hinged blade.

Concerning its usefulness outside of hospital practice, indications will probably be few without extending them beyond the rather narrow limits here recommended. In hospital practice, local preference will, in some quarters, decide, as with the Kjelland instrument, the advisability of adding a new instrument of restricted versatility to the established armamentarium. We believe that a further and more universal trial will win it many adherents.

TABLE III.—BIRTH INJURIES

Type	Number	Caused by Anterior Blade
Facial palsies (all transient)	6	3
Forceps abrasions	12	11
Forceps bruises	8	5
Cephalhæmatomata	2	...
Intra-cranial hæmorrhage	1	...

TABLE IV.—INFANT MORTALITY

"Failed forceps" group

1. A13. See failure 3. Intrapartum. Asphyxia (?).

2. G13. See failure 10. Intrapartum. Asphyxia and birth injuries.

3. G13. See failure 11. Intrapartum. Asphyxia (?).

"Successful forceps" group

4. B9. O-para, aged 26 years. Normal pelvis. Labor at 36 weeks; occiput right; occiput persisting transverse after 51 hours; secondary inertia. Mid Barton rotation and extraction. Neo-natal death. Ante-mortem diagnosis, intra-cranial hæmorrhage, not confirmed at autopsy.

5. H9. I-para, aged 27 years. Normal pelvis. Abruptio placentæ at 38 weeks. Manual dilatation cervix, high Barton application to occiput right posterior, rotation and extraction. Intrapartum. Exsanguination asphyxia.

6. D9. O-para, aged 25 years. Normal pelvis. Placenta prævia in twin pregnancy at 31 weeks. Manual dilatation cervix, high Barton application to second twin, rotation, and extraction. Neo-natal. Exsanguination and prematurity.

7. G10. IV-para, aged 25 years. Normal pelvis. Labor at term; admitted with prolapsed cord and hand. High Barton application to occiput right posterior, rotation; Dewees extraction. Intrapartum. Asphyxia.

8. B9. III-para, aged 27 years. Normal pelvis. Pulmonary tuberculosis; no prenatal care. Admitted in labor 17 hours at 34 weeks, with accidental hæmorrhage; occiput transverse in mid pelvis. Barton rotation and extraction. Neo-natal. Exsanguination and prematurity.

9. F10. O-para, aged 16 years. Normal pelvis. Illegitimately pregnant. Labor at term; occiput in hollow of sacrum after 12 hours. Easy rotation and extraction, after failed Simpson forceps. Intrapartum. Asphyxia.

10. A10. O-para, aged 19 years. Justominor pelvis. Dry labor at 38 weeks; high transverse impaction of military presentation after 48 hours. High Barton rotation; Dewees extraction. Intrapartum. Intracranial hæmorrhage.

11. B9. O-para, aged 19 years. Flat pelvis. Admitted in labor 48 hours at term, with occiput left transverse arrest in mid pelvis. Failed forceps before admission. Morphine administered one hour before delivery. Easy mid pelvic Barton application, rotation and extraction. No apparent injuries. Heart beating at birth, but no respiratory efforts. Neo-natal. Asphyxia (narcosis).

FAILED APPLICATIONS AND FAILED FORCEPS

1. B12. O-para, aged 21 years. Normal pelvis. Late toxæmia. Labor at 38 weeks; occiput right posterior; primary inertia; occiput persisting transverse in mid pelvis after 40 hours. Infant weight, 3,240 grams. Failed application. Delivered by manual rotation and Dewees forceps extraction.

2. C12. I-para, aged 32 years. Normal pelvis. Late toxæmia. Labor at term; hydramnios; myomectomy; head floating after 25 hours. Infant, 3,210 grams. Attempted application resulted in prolapsed cord. Delivered by immediate podalic version. (Error technique.)

3. A13. V-para, aged 35 years. Justominor pelvis. Two previous forceps deliveries. Late toxæmia. Labor at 44 (?) weeks; occiput right posterior; high pelvic arrest with occiput transverse after 13 hours; disproportion, infant weighing 4,100 grams; failed forceps before admission; fetus dead on admission. Failed forceps. Delivered by craniotomy. (Deliberate "error judgment.")

4. B13. I-para, aged 28 years. Normal pelvis. Previous forceps delivery. Labor at 37 weeks; occiput right posterior; occiput persisting transverse in mid pelvis with cervix dilated 3 hours. Failed forceps. Delivery by oblique application of Dewees forceps.

5. C13. XI-para, aged 42 years. Flat pelvis. Previous forceps delivery. Labor at 39 weeks; occiput right transverse floating after 28 hours; disproportion. Infected. Failed forceps. Delivered by cervical cæsarean section. (Deliberate error judgment.)

6. F12. O-para, aged 27 years. Normal pelvis. Labor at 37 weeks; occiput right posterior; occiput persisting posterior in mid pelvis after 16 hours. Infant, 3,840 grams. Failed application. Manual rotation; Simpson extraction.

7. I12. O-para, aged 16 years. Justominor pelvis. Labor at 41 weeks; occiput left posterior; primary inertia; mid pelvic arrest after anterior rotation, 56 hours in labor. Infant, 2,994 grams. Failed application. Delivered by Dewees extraction and episiotomy.

8. E13. VI-para, aged 40 years. Previous forceps delivery. Labor at 41 weeks; occiput right posterior; primary inertia; rigid cervix (cicatrices); 22 hours. Forceps applied with cervix incompletely dilated and effaced. Spontaneous delivery 6 hours later. (Error judgment.)

9. F13. VI-para, aged 33 years. Normal pelvis. Labor at 41 weeks; occiput right posterior; occiput persisting posterior after 60 hours. Failed forceps. Delivered by manual rotation, mid pelvic application of Dewees forceps, episiotomy and extraction.

10. G13. VI-para, aged 35 years. Normal pelvis. Labor at term; occiput right posterior; head floating after 26 hours; disproportion, infant weighing 5,475 grams. Engagement and high rotation by Barton, but further traction ineffectual; Dewees axis-traction to complete extraction. (Error judgment—cæsarean section indicated.)

11. G13. O-para, aged 24 years. Increased pelvic inclination. Late toxæmia. Labor at 42 weeks; occiput right posterior; head floating after 68 hours. Infected. All types of forceps unsuccessful. Infant viable. Cervical cæsarean section. (Deliberate error judgment.)

12. J13. I-para, aged 32 years. Previous version. Increased pelvic inclination. Labor at 39 weeks; occiput left anterior; head floating after 36 hours. Infant, 3,085 grams. Failure to secure engagement with Barton. Delivered by podalic version and after-coming-head forceps.

REFERENCES

GREENHILL, J. P. Am. J. Obst. Gynec., 1924, vii, 349.
JARCHO, J. Am. J. Obst. Gynec., 1925, x, 35.
SCHUMANN, E. A. Am. J. Obst. Gynec., 1926, xi, 525.
WILLIAMSON, H. G. Am. J. Obst. Gynec., 1926, xi, 37.

FROM THE ORTHOPEDIC HOSPITAL OF VIENNA

OPERATIVE CORRECTION OF CLAW-FOOT

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AMONG the various foot deformities, claw-foot occupies a unique position. It is the opposite of flat foot in that all the signs and symptoms are exactly the reverse of those seen in flat foot. The calcaneus is vertical, the tuberosity of the calcaneus looks downward, and, as in the Chinese foot deformity, the arching of the foot is intensified by a curve of short radius. The heads of the metatarsal bones appear nearer the tuberosity of the calcaneus, the length of the foot is essentially shortened, and the tarsal joints are contracted to the claw shape which gives the deformity its name.

After a considerable length of time the bones naturally adapt themselves to the situation and the joints change accordingly, the musculature and ligaments in their functions likewise depending on these changes, or, if we wish so to express it, the changes in the function of the musculature and ligaments serve as the original activating cause of these changes in the foot. Changes of equilibrium of the muscles of the foot and of the lower part of the lower extremity are the fundamental causes in this deformity.

The most severe cases are congenital The cause is usually myelodysplasia, a derangement of development of the lower segments of the spinal cord, where the nerve cells controlling the musculature of the foot are located. This deformity frequently manifests itself as spina bifida, the delay of closure of the canal of the spinal cord.

Other derangements of the central nervous system such as syringomyelia and multiple sclerosis result in talipes cavus. Other types of paralysis of the peripheral nerves may produce this deformity.

Not infrequently we observe a lateral deviation of the foot, a pes valgus or more often a pes varus. These directional deviations from the normal are particularly apt to occur when talipes cavus is not pronounced. In these cases it is possible quite often, with a mechanical apparatus or a corrective shoe, to obtain partial relief without operation.

If the lateral deviations increase, but without a pronounced talipes cavus and so without marked discomfort, it is possible to correct the condition by transferring the muscular control. This is done by means of tenoplasty, muscular equilibrium being restored by transplanting the muscles and tendons which control function from the inner to the outer side of the foot, or vice versa.

When the talipes cavus becomes very marked, the contractions in the tarsal joints are very noticeable. The heads of the metatarsal joints drill holes in the sole of the foot. The massive shoe sole causes painful calluses which interfere with locomotion.

The pain and handicap in walking cause the patient to seek relief. Our old textbooks recommend manual correction for the deformity. Many types of apparatus have been devised to throw constant pressure on the instep of the foot in order to flatten down the extreme high arch.

Anyone who has tried to reduce a typical hollow foot knows that the contracting force required is enormous. The overcorrecting force is so great that the leverage action would crush the bones; indeed the operation is a very bloody one although no incision of the skin is made.

During the first trial at correction we are impressed with the fact that the fascia plantaris and the deeper portions of the muscles are at the highest degree of tension. The subcutaneous division of the fascia plantaris and the subsequent cutting of the flexor brevis muscle do not lead to the desired result; a remarkably powerful resistance can still be noticed. Added to that is the danger of rupture on account of shortness of the skin of the sole of the foot, especially when its continuity has been weakened through a tenotomy wound.

For these cases of severe talipes cavus I have therefore devised an operation which satisfactorily fulfills the above requirements and avoids the dangers mentioned.

TECHNIQUE

A semilunar incision which would correspond to the upper brim of a slipper ("slipper incision") is made 3 centimeters above the sole of the posterior half of the foot. The incision is started at the height of the arch on the inner side and ends at the tuberosity of the fifth metatarsal bone. Next the entire flap is dissected off with the underlying soft tissues from the heel. At the point of its insertion, the fascia plantaris is removed with

Fig. 1a (left). High degree of claw-foot (spina bifida imperfecta) before operation.

Fig. 1b. The right foot was operated on 8 months ago, while the left foot was operated on only 3 months before taking the photo.

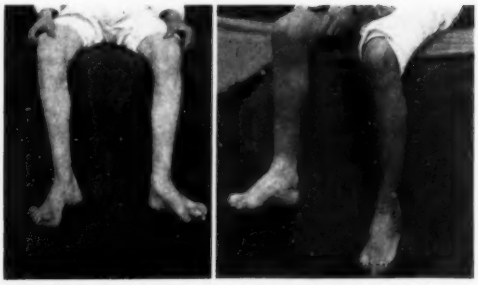

Fig. 2a (left). High degree of claw-foot. (Before operation.)

Fig. 2b. Three months after operation of right foot.

a chisel and the flexor brevis muscle is then severed from the os calcaneus.

Now the entire flap, which comprises the skin of the sole of the foot, the subcutaneous tissues, the fascia plantaris, the flexor brevis muscle, and also the abductors of the toes and the musculus quadratus plantæ are bluntly dissected from the bony surface of the calcaneus and distally (anteriorly) retracted.

The points of danger to be avoided are first of all injury of the posterior tibial artery. With great care during the preparation of the flap, this can be easily avoided by working more on the inner side. The vessels, the posterior tibial artery with its two terminal branches, the internal plantar artery and the external plantar artery run on the surface of the musculus flexor brevis and the musculus quadratus plantæ. Therefore if the flap is turned carefully to the inner side where the vessel passes the inner edge of the foot and the entire separation of the flap from the inner side is avoided, no injury will be done to the posterior tibial artery.

However, should it happen that during the exposure of this area of operation, injury is not successfully avoided, ligation of the posterior tibial artery will not cause severe consequences. The arteries of the heel provide such a rich blood supply to the sole of the foot that any disturbances of nutrition are prevented. In no case of injury to the artery followed by its ligation have we ever found any serious postoperative derangement of nutrition.

Proceeding with the operation, we look for the tendon of the musculus peroneus longus, the tendon being tightly attached to the bone. The flap is separated and removed by blunt dissection, an operation which can be easily carried out after the insertion of the fascia plantaris has been chiseled off. The long plantar ligament, which can be seen in the bottom of the field of operation is diagonally incised. External to this lies the calcaneonavicular plantar ligament which has to be definitely dissected like the calcaneocuboid ligament between the navicular and cuboid bones.

After these steps in the operation, we try to redress the foot and are surprised to find that there is still considerable resistance. And it is only after all the ligaments under tension have been cut that the tension is relieved and the foot is brought into proper position. The length of the foot is now increased about 3 centimeters, the point of insertion where the chiseling was done tilts forward about 3 centimeters, and the calcaneus can be placed in a horizontal position, if the ligaments which really held the calcaneus in the perpendicular position were separated.

When the correction is successfully completed, the flap is replaced. It is now clear why the heel incision had to be made so high up, since otherwise the incision would have been too near the sole of the foot and the edges would have gaped backward at the heel about 2 centimeters and later even under the most successful care, granulation would have occurred and no shoe could be worn without pressure on the scar.

However if the incision is made high on the back of the heel and there is great tension, a lateral union of the integument of the lower leg will take place and no gaping will result.

In every case powerful big biting stitches should be taken.

In severe contracted claw-foot with hammer toes, if the toes still show marked deformity after the operation described, the tendons of the extensor longus digitorum and other extensors of the foot are transplanted from the toes to the metatarsal heads. In two incisions the tendons of the extensors are exposed and freed and the extensor hallucis longus transfixed to the first metatarsal and the tendons of the extensor longus digitorum (communis) on the third metatarsal head. The sutures, placed either perosseally

Fig. 3. Plaster casts before and after operation.

or circularly around the metatarsi, hold the tendons embedded in the fissured periosteum.

With my elevators, which have eyes, the sutures can easily be led around the bones. To perforate the bones for perosseal sutures, I use drills which I have adapted from the ivory carving trade. They are more or less slightly curved, hollow sounds which can be used as drills or perforators. The steel has to be hard and resistant and yet must not be fragile. Since these instruments were designed originally for drilling ivory and for carrying wires within elevators for perforating ivory they are very practical for use in human bones which are considerably easier to manage. These drills or perforators have a trough-like groove through which a suture on a needle can be passed, so that with them tenoplasty can easily be performed.

If in the first stage of the operation the posterior tibial artery has been injured and ligated, in the second stage we have to be very careful. Extreme care has to be exercised not to injure any blood vessels for even with perfect knowledge of the distribution of the blood vessels on the dorsum of the foot, they might be easily injured as they run plantarward between the two heads of the first dorsal interosseous muscles (between the first two metatarsi). Such injury would produce marked necrosis and gangrene.

The wound is closed with catgut sutures and an immobilization splint carefully applied. The splint gives sufficient support for correction, therefore I lay special stress on the dressing of the operative area. I use overdressings of gauze and over that a hard thick cardboard sole, against which the easily manageable foot is now immobilized. With a roll of gauze the region of the metatarsal heads is elevated to the natural arch and another roll of gauze is placed over the toes. Another piece of cardboard well padded, 2 to 3 centimeters thick, is placed over the toes and secured so as to hold the toes in plantar flexion. The whole is covered with a plaster-of-Paris spica which reaches almost to the flexed knee. After 4 weeks of rest, the cast is removed. The desired correction was obtained in every one of our cases as can be seen in the pictures of the plastic models.

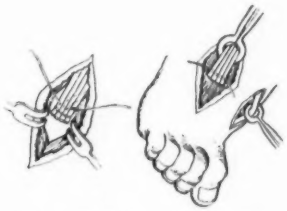

Fig. 4. Technique of operation.

For after-treatment, walking exercises of weight bearing are encouraged, in which the important feature is the "rolling off" practice of the foot. These exercises consist of the patient's standing up on the heel and gradually rolling off the foot toward the metatarses. With the assistance of the flexor hallucis longus the big toe is pressed down to the ground, through which a completely normal rolling motion of the foot is obtained. Compare this with the previous claw position, when the toes only partially and with their tips instead of the plantar surface of the first and second phalanges took a share in the action. Massage of the lower limb and the extensors of the foot complete the treatment.

Under supervision for many years the observations prove that the corrections are successful and the results have shown the operation to be perfectly reliable. No braces are employed, but shoes with very thick, strong, flat soles. The patients are directed to place shoe trees in the shoes at night in order that the flat surface of the shoe sole shall be preserved and the tendency of upward bending of the tip of the shoes prevented, as this favors the claw-foot formation which is to be avoided.

The operation in the above described proceeding was performed for the first time in 1922 and resembles only in the first stage the technique of Steindler, but the original technique was already introduced at my hospital during the war, when there was no communication of reports existing.

COMPLETED ASEPTIC TECHNIQUE FOR THE IMPLANTATION OF THE URETER INTO THE LARGE BOWEL[1]

By ROBERT C. COFFEY, M.D., F.A.C.S., Portland, Oregon

IN the May, 1925, issue of *Northwest Medicine*, I published a paper entitled, "A Technique for Simultaneous Implantation of the Right and Left Ureters into the Pelvic Colon Which Does Not Obstruct the Ureters or Disturb Kidney Function," and I sent reprints of the article to members of some of the special surgical societies. The new feature of this operation was the fastening of rubber tubes in the ureters for the purpose of maintaining a patent canal for the passage of the urine through the traumatized intestinal wall during the first few days of convalescence. The first operation by this method was done on a patient with dilatation of both ureters as a result of cancer of the bladder and uterus. The advantages of the technique seemed apparent to nearly all surgeons who received the reprint. However, in this case the condition was very far advanced; radium in large doses and two major abdominal operations were necessary so it was not a perfectly fair test. Two weeks after operation, the left abdominal incision broke down, and a large quantity of pus was discharged; nevertheless, clear urine was freely discharging from the rectum. About 2 months after the operation, the patient died of exhaustion, with clear urine still coming from the rectum up to the time of death. Postmortem examination showed that the right kidney was normal. The left kidney was filled with miliary abscesses which seemed to be an extension of a process which had originated at the opening in the intestine from which the abscess had developed. In other words, we had a true ascending infection along the wall of the ureter.

In former experiments with ureteral transplantation in animals, the greatest source of danger seemed to be infection emanating from the opening in the intestine. There seemed to be no way to procure a sterile field for this operation.

After the publication of this paper and after the postmortem examination in my case, I immediately established a dog hospital in connection with the University of Oregon Medical School and started to work out means of overcoming

Fig. 1. Intestine clamped. Pointed cannula inserted for irrigating the bowel.

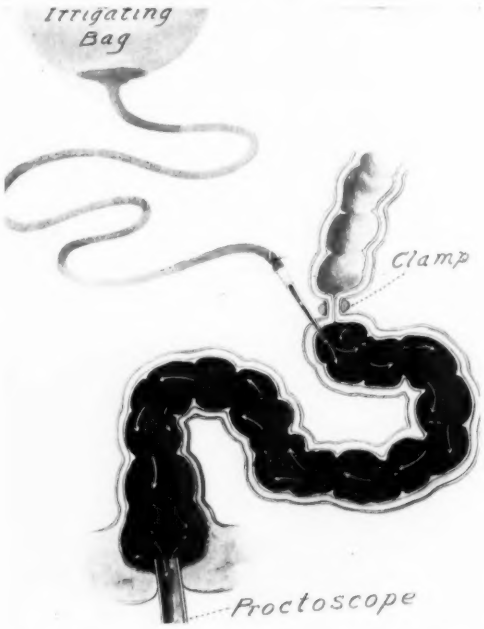

Fig. 2. Sigmoidoscope introduced, rectum being flushed.

[1]This Technique was presented in address before the Clinical Congress of the American College of Surgeons in October, 1925.

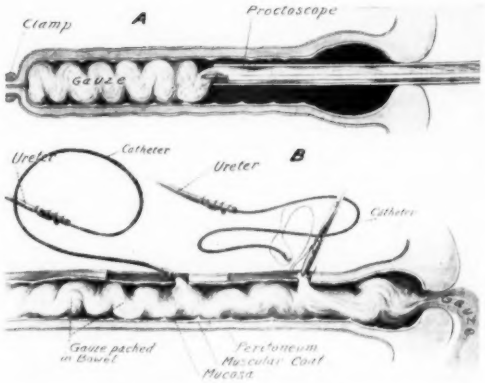

Fig. 3. *a*, The rectum is packed with dry gauze through the speculum. *b*, Showing diagrammatically the intestine packed with gauze, ureters prepared for implantation, and method of attaching end of catheter to gauze through stab wound in mucosa.

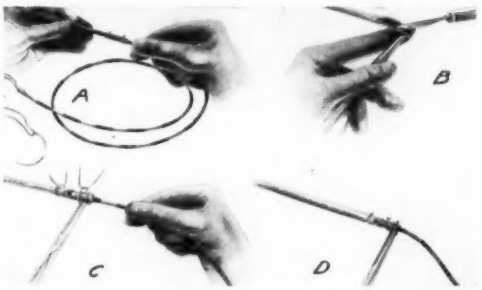

Fig. 4. Ureteral catheter is prepared and fastened in the ureter. *a*, The anchor cuff is fastened on the catheter by two ligatures. *b*, Forcep holding ureter held in left hand. Ureter being split. *c*, End of ureter is being fastened to the anchor cuff by a double ligature. Also it is being fastened around the ureter by another ligature. *d*, Completion of fixation of the catheter in the ureter.

the possible difficulties to be encountered in this operation. We found that (1) infection emanating from the incision in the intestine was the most frequent cause of immediate fatality following the implantation of the ureter; (2) it was difficult to find a rubber tube stiff enough to withstand a ligature which is later to cut through the ureter and at the same time of sufficient caliber to carry the urine; (3) a ureteral catheter if large enough is ideal but as it is smooth, it easily slips out of the grasp of the ligature which has been thrown around the ureter. These difficulties had to be overcome.

For this purpose the following technique was developed and proved both experimentally and clinically.

The bowel is thoroughly cleared with castor oil the day before operation. It is flushed out thoroughly from below 2 hours before operation. The abdomen is opened low down and near the midline. All the small intestines are packed back with gauze, while the sigmoid is pulled down into the field of operation. The upper end of the movable sigmoid is clamped in a rubber covered thin bladed stomach clamp. A sigmoidoscope with obturator is inserted into the lower rectum. A pointed cannula of sufficient caliber to admit the passage of a considerable stream of water is attached to the tube of an irrigator (Fig. 1). The cannula is inserted through the wall of the intestine. The flow is started (Fig. 2). The pelvic colon below the clamp is thoroughly irrigated until the water comes entirely clear, after which the cannula is removed and the puncture closed with a suture or two. After the water has all been discharged through the sigmoidoscope, an assistant inserts the obturator and passes the instrument up through the sigmoid under the guidance of the hand of the operator. Then with a small, long handled forceps such as is used in œsophagoscopy, a long strip of gauze is pushed through until the rectum is packed full of this dry gauze, the sigmoidoscope being gradually withdrawn as the rectum is filled. The gauze absorbs all of the remaining fluid in the intestine and also establishes a contour which makes the operation much easier (Fig. 3).

The ureters are now located and severed between small artery forceps as near to the bladder as possible. The distal stump is cauterized with carbolic acid and is ligated. The proximal end of the ureter is liberated for 3 or 4 inches by slitting the peritoneum over it. As large ureteral catheters as will comfortably go into the ureters are prepared. However, No. 8 answers the purpose splendidly. A piece of rubber tubing about ¾ inch in length, large enough to pass over the catheter comfortably is threaded on to the catheter to a point 4 to 6 inches above its tip. Two or three strong linen threads are now tied around this rubber cuff which is to be used as an anchor to hold the ureter. A fairly small needle armed with strong linen thread is made to take a bite of one wall of the end of the catheter. This is knotted leaving a free end 3 or 4 inches long (Fig. 4a). Gauze is packed in the pelvis around the sigmoid and around the ends of the ureters. Owing to the fact that these tubes are liable to become blocked with débris, it is sometimes necessary to remove the tubes before they come away naturally. Therefore, the ureters should

Fig. 5. The incisions being made for the implantation, anchor sutures being placed at the lower angle of one wound preparatory to making the stab wound in the mucosa. The catheters and ureters are ready for implantation.

be planted as low down in the rectum as possible so they may be cut loose through a speculum or

Fig. 6. Ureteral catheters are being fastened to the gauze within the intestine through a small stab wound. Note the anchor sutures used to control the intestine during the operation.

Fig. 7. The ureter has been drawn well into the lumen, the traction loops are being tied and the various sutures are being placed to cover in the ureter and bring it into its submucous position.

proctoscope, if necessary. An obstructed tube rapidly destroys a kidney.

To avoid too much narrowing, one incision should be higher up the bowel than the other. The incision should begin near the mesenteric edge and extend downward and obliquely toward the antemesenteric border so as to avoid as many of the large vessels as possible. The incision should be about an inch and a half in length and should go through the peritoneum and muscle, permitting the mucosa to pout out partially through the incision (Fig. 5). After both incisions are made, any considerable bleeding is controlled.

We next take up the ureter which is held in an artery forceps in the left hand. The index finger is held under the ureter as a rest. With a knife in the right hand, an incision is made into the ureter (Fig. 4b). The catheter is now inserted into the ureter down to the cuff. A strong linen thread is passed twice around the split ureter and cuff and tied tightly with a double or surgeon's knot. A similar suture is then tied around the ureter below the incision so as to prevent infection ascending the ureter from the bowel (Fig. 4c and d). Urine usually begins to

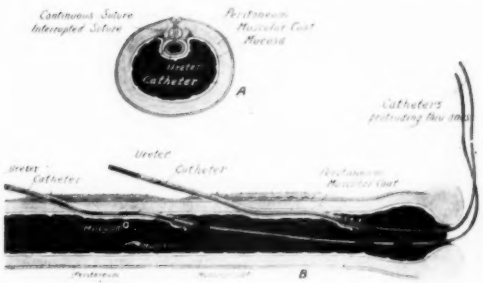

Fig. 8. Diagram illustrating the completed operation and the relation of the ureter to the mucosa.

escape from the catheters at once. We next turn to the intestine. A curved needle armed with double o chromic catgut suture is made to pick up a bite of the mucosa and then pass out and pick up a bite of the muscle and peritoneum great care being used not to include the gauze within the intestine in the suture. This suture is tied and a free end about 4 inches long is left. These free ends are used as traction sutures for perfect control of the mucosa during the later steps of the operation. A small stab wound is made in the mucosa between these traction sutures. A mosquito forceps picks up a little of the gauze and to this the end of the catheter is attached by the suture already provided (Figs. 6 and 3b). After both of the catheters are thus attached to the gauze a nurse gradually withdraws the gauze from the rectum and in so doing the ureteral ends are drawn into the openings in the mucosa. The catheters must be marked in some way so as to indicate the right and left kidney. After the ureter is drawn in past the ligature, the free ends of the two traction loops are tied across the ureter so as partially to close the opening. These traction loops are very important in handling

Fig. 9. Two-year-old child on whom bilateral transplantation by this method was done 3 months before picture was taken. Child is perfectly healthy, holds the urine from 3 to 6 hours in the rectum.

the intestine. Next a needle threaded with triple o chromic catgut suture doubled is made to pick up one edge of the cut in the mucosa, pass across the cut, pick up a bite of the ureter and then the other side of the cut mucosa. This suture is tied and effectually holds the ureter in place and closes the stab wound around it. Another suture is made to take up the serous and muscular coats and also to pick up a bite of the ureter as it crosses. This holds it very effectually. It is not wise to permit more than two sutures to puncture the ureter. Other sutures are made to bring the serous and muscular coats over the ureter thus placing it in the submucous position. The needles and the long ends of the traction loops are used to bring the peritoneum across the deeper suture (Fig. 7).

THE TREATMENT OF BLADDER TUMORS BY CHEMO-COAGULATION

By LEO S. DREXLER, M.D., Brooklyn, and WILLIAM GINSBERG, M.D., New York
From the Urologic Clinic of Professor Eugen Joseph, Universitaets Klinik, Berlin, Germany

THE results during recent years concerning the treatment of bladder tumors have clearly demonstrated that whenever possible the endovesical procedure is the method of choice. Patients treated endovesically are less prone to recurrent metastatic growths inasmuch as there is not such an extensive opening of the blood and lymph vessels. In addition, endovesical treatment is much easier to perform, does not require putting the patient to bed, and can be utilized in the treatment of malignant, as well as benign, growths of the bladder.

With the introduction of electrocoagulation by Beer in 1913 marked advances in the endovesical treatment of bladder tumors have been made. Electrocoagulation has given excellent results in the treatment of small, easily accessible papilloma and also in moderately enlarged pedunculated papilloma. It can also be utilized advantageously in moderate sized bleeding papilloma provided the bleeding vessels can be reached with the electrocautery. Not all bladder tumors, however, can be ideally treated by electrocoagulation, especially growths of large size, growths which are necrotic and foul smelling, and growths in which the bleeding is rather marked. It, therefore, behooves us in such cases to use some other method of treatment which by itself or combined with electrocoagulation is capable of eradicating the tumor growth. In such cases we recommend the use of chemocoagulation.

Since the year 1903 various attempts have been made by Frank, Praetorius, Papin, and others to treat bladder tumors endovesically by means of chemical agents. Not until the year 1919 with the introduction of the use of trichloracetic acid by Professor Eugen Joseph did chemocoagulation take a definite rôle in the treatment of bladder tumors. Joseph definitely showed that we can penetrate tumor tissue deeper with chemocoagulation than with electrocoagulation; that small papillary tumors can be entirely eradicated; that large diffuse papillary growths can be readily reduced in size and in this way prepared for further treatment with electrocoagulation; and that in large bleeding tumors the acid arrests the hæmorrhage by producing a thrombosis of the bleeding vessels.

During the past 8 years over 50 cases of bladder tumors, benign and malignant, have been treated at the clinic of Professor Joseph either by chemocoagulation alone or combined with electrocoagulation. It has been our good fortune to have been able to follow some of these cases through their entire course, and we therefore present briefly the findings thereof.

I. S., age 40 years, admitted to hospital February 7, 1927. Five years ago patient was operated upon suprapubically and a bladder tumor removed. On admission she complained of painful and bloody urination. The urine was cloudy and bloody; alkaline in reaction, foul smelling, and showed many leucocytes and red blood cells microscopically. Cystoscopic examination revealed bladder capacity to be 100 cubic centimeters, and disclosed a solid ulcerated tumor about the size of a small apple situated at the base of the bladder, and marked cystitis with fibrinous exudate. Neither ureter was visible.

Chemocoagulation treatment was given on February 12, 1927; two to three bladder washings being given weekly until the next examination.

Examination on February 28, 1927, showed the urine to be cloudy, no blood, tumor markedly reduced in size, only slight necrosis present, and both ureters readily visible. Case now ready for further treatment with electrocoagulation.

M. U., age 56 years, admitted to hospital August 27, 1926. Since 1920 patient has undergone electrocoagulation at various clinics for the presence of a bladder tumor.

Cystoscopic examination revealed a large solid ulcerated tumor at the base of the bladder overlying the right ureter; the tumor mass covered with fibrinous exudate. A section of a portion of tumor tissue showed the presence of an atypical benign papilloma.

Chemocoagulation treatment was given on September 6, 1926, followed by bladder irrigations twice weekly; electrocoagulation, October 3, 1926; and chemocoagulation again on December 14, 1926. Examination on February 2, 1927, showed that the tumor mass had entirely disappeared and was replaced by scar tissue. The right ureter was visible, the left ureter somewhat displaced because of traction due to scar tissue.

The technique of chemocoagulation is as follows. After the introduction of a normal-sized catheterizing cystoscope, the bladder is washed and filled as for any cystoscopic procedure. A catheter is introduced into the cystoscope, the tip of the catheter having been cut off so that the acid will flow directly from the cut end and not from the side opening. The trichloracetic acid must be freshly prepared. For this purpose, we employ chemically pure trichloracetic acid crystals which on heating to 55 degrees C. go into solution and

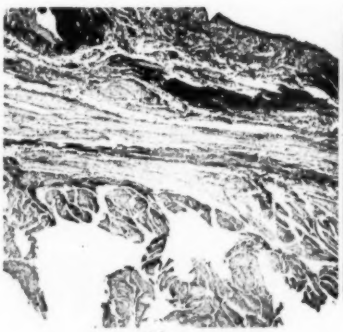

Fig. 1.

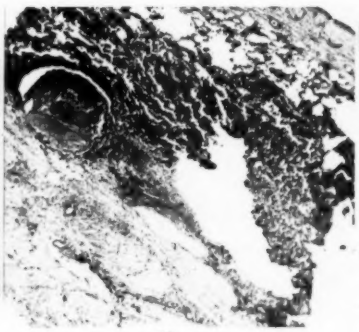

Fig. 2.

Fig. 3.

Fig. 1. Beginning necrosis at end of 12 hours.
Fig. 2. Necrosis extending to muscularis—24 hours.
Fig. 3. Forty-eight hours. Well demarcated necrosis to muscularis.

recrystallize on cooling. With a spatula we place enough of the crystals into a test tube so that on heating a solution of 4 to 5 cubic centimeters is formed. To this is added 5 drops of glycerine. The test tube containing the solution is then placed in a glass of warm water so as to prevent recrystallization before using. One cubic centimeter of the solution is then drawn up into a glass syringe (metal syringe cannot be used), and while the cystoscopist directs the catheter over the upper surface of the tumor mass, an assistant slowly syringes the solution through the catheter, using from 20 to 30 drops. At first one notes the presence of a few air bubbles which is then followed by the appearance of the acid. The tumor mass takes on a snow white appearance due to the action of the acid. After the treatment, the bladder is emptied and washed. Should the patient complain of much pain after the treatment, one can introduce into the bladder 40 to 50 cubic centimeters of an anæsthetic solution, such as 1 per cent alipin.

Tumors situated in an area of the bladder not accessible with the cystoscope can be treated with frequent instillations into the bladder of 40 to 50 cubic centimeters distilled water containing 20 to 30 drops of trichloracetic acid. Long standing hæmaturia from bladder tumors can also be brought to a standstill in this manner. Occasionally one encounters tumors on the anterior wall of the bladder. Such tumors can be treated endovesically by placing the patient in the knee-chest position.

After coagulation, the patient returns two to three times each week for bladder irrigations. During this period much fibrin is thrown off and the urine is cloudy. Cystoscopic examination reveals a necrotic mass white or grayish white in color and surrounded by a circumscribed area of bullous œdema which subsides in from 10 to 20 days. During this time no further treatment should be instituted, as it is often difficult to differentiate cystoscopically between œdematous and true tumor tissue. At the end of 2 to 3 weeks the tumor mass has either entirely disappeared and been replaced by scar tissue or has been markedly reduced in size and ready for further treatment by chemocoagulation or electrocoagulation. In some cases after chemocoagulation there is a rapid regeneration of mucous membrane over the tumor mass which soon becomes epithelized and renders the mass very resistant to further treatment with trichloracetic acid. Such cases are best treated with a preliminary electrocoagulation followed by the instillation of the acid at the site of cauterization.

Objection has been raised against chemocoagulation on the ground that the trichloracetic acid may be capable of producing a perforation of the bladder wall. Joseph has never observed any such untoward result in any of his cases in spite of the fact that frequently during the treatment a few drops of the acid will spill on the normal bladder mucosa. To prove our contention that trichloracetic acid cannot produce a perforation of the bladder wall, and to determine the depth of action of the acid, we have carried out the following experiments on a series of dogs.

Seven dogs were employed, each dog having been shaved and carefully prepared for operation. Under morphine-ether anæsthesia, the abdomen was opened aseptically and the bladder exposed and opened. One cubic centimeter of trichloracetic acid was then applied to the posterior wall of the bladder through a syringe. The bladder and abdominal walls were then closed and

Fig. 4. Seventy-two hours. Showing well demarcated necrosis.

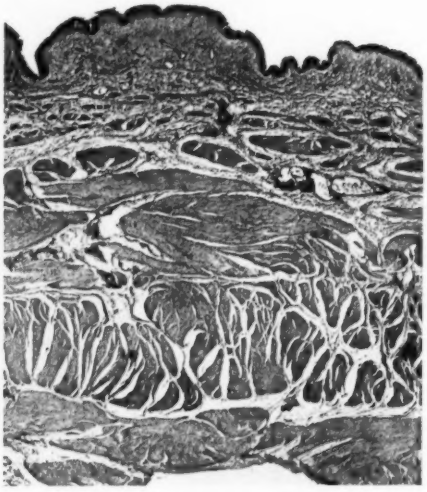

Fig. 5. Complete healing with regeneration of the mucous membrane at the end of 2 weeks.

each animal allowed to live for varying lengths of time. In each case, healing was by primary union. At the end of each specified period the dogs were killed and the bladders examined macroscopically and microscopically to determine the immediate, intermediate, and end-results of the action of the acid, and also the depth of the reaction. Over four hundred serial sections were made, some of which are shown below.

Dog 1 was killed at the end of 6 hours. Macroscopic examination revealed an area of bullous œdema at the site of application of the acid. No evidence of any necrosis. Microscopically the epithelium appeared intact with slight subepithelial hæmorrhages. There was a localized œdema with a leucocytic infiltration down to the muscularis.

Dog 2 was killed at the end of 12 hours. Macroscopic examination revealed an area of beginning necrosis at the site of application of the acid, surrounded by bullous œdema. Microscopically the above area showed a defect in the epithelium extending down to the submucosa and definitely demarcated by a leucocytic infiltration. With this there was an associated œdema.

Dog 3 was killed at the end of 24 hours. Macroscopic examination revealed an area of necrosis at the site of application of the acid, the necrotic mass being firmly adherent to the underlying tissue. Completely surrounding the area of necrosis was a bullous œdema extending about 2 centimeters from the margin of the necrotic zone. Microscopically the necrosis was more marked than in the previous section. It extended down to the muscularis and was surrounded by a leucocytic infiltration. The œdema was less marked (Fig. 2).

Dog 4 was killed at the end of 48 hours. Macroscopic examination revealed an area of necrosis at the site of application of the acid. The necrotic tissue was firmly adherent to the underlying tissue and surrounded by an area of bullous œdema. Microscopically there was a well demarcated necrosis extending down to the muscularis. Œdema very slight. Some round cell infiltration in the subserosa. (Fig. 3.)

Dog 5 was killed at the end of 72 hours. Macroscopic examination revealed an area of necrosis surrounded by bullous œdema. The necrotic area was well demarcated and could readily be removed from the underlying tissue. Microscopically the demarcation was more pronounced with a round cell infiltration separating the area of necrosis from the muscularis (Fig. 4).

Dog 6 was killed at the end of 2 weeks. Macroscopic examination showed no evidence of any reaction at the site of application of the acid. The mucous membrane was intact. Examination of the kidneys revealed no evidence of any ascending infection. Microscopically there was a connective-tissue replacement of the submucosa with a regeneration of the mucous membrane (Fig. 5).

Dog 7 was killed at the end of 4 weeks. Macroscopic and microscopic examination revealed complete healing at the site of application of the acid. The kidneys showed no evidence of any ascending infection.

In none of these experiments was there any evidence of perforation or permanent injury of the bladder mucosa.

CONCLUSIONS

From the foregoing experiments we can conclude that trichloracetic acid can safely be used in the treatment of bladder tumors. It cannot produce a perforation of the bladder wall, the depth of reaction being limited to the muscularis.

Clinically we can conclude that in the treatment of bladder tumors, both benign and malignant, the endovesical approach is the method of choice. Possible exceptions to this are favorably located infiltrating carcinomata in patients of

good general condition, in which cases resection is more advisable.

Small benign papillomata are best treated by electrocoagulation, whereas larger atypical papillomata, especially those showing evidence of active bleeding, are best treated by chemocoagulation with trichloracetic acid, or by a preliminary chemocoagulation followed by electrocoagulation, depending on the size of the tumor mass.

Chemocoagulation should be employed in the treatment of all bladder tumors showing evidence of beginning malignant changes.

Chemocoagulation is especially indicated in those cases of bladder carcinomata presenting marked foul smelling necrosis and bleeding with secondary cystitis. In this way the necrosis and bleeding can be cleared up and the tumor mass reduced in size sufficiently to allow further treatment with electrocoagulation.

Chemocoagulation cannot prevent metastasis and recurrence of bladder tumors, but can prolong the life of the patient by clearing up the local condition. In the clinic of Professor Joseph we have observed several cases of inoperable papillary carcinoma of the bladder which have undergone treatment with chemocoagulation and are still doing well at the end of 4 to 5 years.

Chemocoagulation has no permanent injurious effect on the normal bladder mucosa even if accidentally spilled during the treatment. Its reaction consists of a bullous œdema with or without a superficial necrosis. The œdema readily subsides, whereas the necrotic area is restored to normal or goes on to scar tissue formation which in no way causes any physiological disturbance.

BIBLIOGRAPHY

Gaudy, J., and Schillings, M. Les Tumeurs de la Vessie.

Gottlieb, J. G. Chemocoagulation of Bladder Tumors. Urologia, Moscow, 1925, viii.

Joseph, E., and Schwarz, O. A. Erfahrungen ueber die epithelialen Geschwuelste der Harnblase. Ztschr. f. urol. Chir., 1923.

Joseph, E. Ein neue Methode zur Behandlung der Blasengeschwuelste. Zentralbl. f. Chir., 1919.

Idem. Kystoskopische Technik. Springer, 1923.

Idem. Die Behandlung der Blasengeschwuelste. Ztschr. f. Urol., 1925.

Wossidlo, E. Electrocoagulation und Chemocoagulation von Blasen Tumoren. Ztschr. f. urol. Chir., vol. xiii.

A NEW METHOD OF COVERING DENUDED AREAS WITH THE SURROUNDING SKIN

By E. D. HIGHSMITH, M.D., F.A.C.S., Atlanta, Georgia

From the Department of Surgery, Emory University School of Medicine

My purpose in this report is to describe a method of covering raw surface with the surrounding skin instead of with a pedicled flap or with skin grafts. In the repair of wounds of the face or injuries of any part of the body in which infection has been present and there has been a great loss of skin and underlying soft structures it is customary to allow the infection to clear up and the wound to granulate. Several months are then allowed to elapse to make sure that no infectious organisms are present before any effort is made to finish the operation. If the area involved is a bearded surface, it is hardly possible to graft skin to correspond with the surrounding area. A moment's consideration will show that a better method is to apply traction on either side of the wound sufficiently strong to overcome the normal tension of the skin. In this way the margins of the skin on each side are brought in apposition. By the time the affected space has filled in, it is usually covered with normal skin which corresponds with the surrounding area.

We have all seen skin proliferate when called on to do so from an underlying pressure such as that from large cystic goiters or lipomas.

To get the best results in wounds in which there has been extensive skin destruction continuous traction should be applied on either side of the wound immediately, before the margins of the skin are bound down by scar tissue. In this way the area is soon covered. The rapidity of repair depends on the amount of traction applied. If the skin is carried across the surface faster than the granulations fill in, there will be a depression, which may later be filled in by a graft. This method is a great time saver for the patient, as the raw surface is soon covered and he can select the time best suited for the final operation.

The young man shown in Figure 1 was accidentally shot at close range with a shot gun, January 18, 1926. A large area of the skin and

Fig. 1. Appearance of patient January 27, 1926, 9 days after injury.

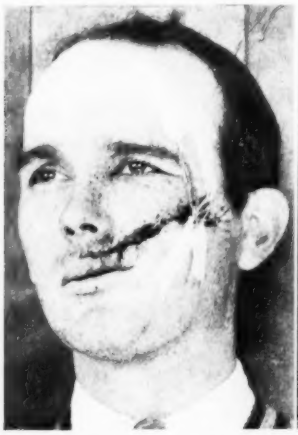

Fig. 2. About 15 days after treatment by traction method.

Fig. 3. Showing appearance on March 4, 1926.

Fig. 4. Method of applying traction by rubber bands, in attached hooks on each side of wound to produce desired tension.

Fig. 5. Showing extent of improvement by July, 1926, 6 months after injury.

soft structures and a portion of the molar bone were torn away, and the antrum was opened. He was first treated by the traction method, February 1, 19 days after his injury.

TECHNIQUE

The loose epithelial cells and oil from the skin on each side of the wound are removed by rubbing with a sponge saturated with ether. The ordinary dress hook fasteners are sewed on pledgets of gauze, one-half inch wide by 1 inch long.

These strips are thoroughly saturated on the under side with Carpentier's court plaster, and are placed near the skin margin on each side of the wound in such a manner that small rubber bands can be fastened in the hooks in order to produce continuous traction and gradually draw the skin margin together. To avoid irritation of the skin, these pledgets of gauze should not remain in the same position longer than 48 hours. When they are removed they should be reapplied in a different location.

RECONSTRUCTION OF THUMB AFTER TOTAL LOSS

By GEORGE WARREN PIERCE, M.D., San Francisco

THE thumb is the keystone of manual dexterity. Try to pick up a pin, a coin, or even a pencil without using the thumb, and its value becomes strikingly evident. Consider then the devastating effect of the loss of this factor of the hand upon a skilled artisan whose livelihood depends on his manual skill. In this day of machinery there are a multitude who have suffered this injury.

When I was confronted with such a patient, the possibility of reconstruction of the member suggested itself. The resultant of the several stages was a successful summation of the original plan and the value of the cosmetic result, which was fair enough, was far outreached by the restoration of function, the power of apposition of thumb to fingers. The patient was enabled to resume at once his former occupation of assembling locks, which requires considerable manual dexterity.

The author desires to report the history and method pursued in this case.

On September 24, 1924, F. R., age 25, lost the thumb of the right hand by crushing it in a press. There was complete severance through the thenar eminence just distal to the carpometacarpal joint. Within 3 hours the patient was hospitalized and a complete débridement of the wound was done under gas anæsthesia. The torn adductors of the thumb were sutured around and over the stump of the first metacarpal but, aside from this, the wound was not closed. Normal saline compresses were applied and cultures taken daily. No growth was revealed and on the fourth day the raw area was covered with Thiersch graft in a single piece. The graft was splinted with rubber sponge, the author adopting this method, as he realized the necessity for a constant even pressure which is difficult to control in this region. The use of rubber sponge as a splint for grafts will be reported elsewhere. The entire graft was successful.

Figure 1 shows the hand after the skin graft had been made.

Two weeks after the injury a tubed pedicle of the Gillies type was made on the right side of the abdomen. Four weeks later, or six weeks after the injury, the lower end of the tubed pedicle was severed from the abdomen, the skin graft was dissected from the thenar eminence and the end of the pedicle was sutured to the defect. The arm was maintained by a sling and swathe. Healing was uneventful and 3 weeks after operation, or 9 weeks after injury, the pedicle was severed from the abdomen and the free end closed.

A considerable period was then allowed to elapse to permit shrinkage of the grafted pedicle. This shrinkage proved to be very moderate.

Figure 2 shows the pedicle at that time.

On April 22, 1925, 7 months after injury and 5 months after completion of grafting the pedicle to the hand, a bone graft 8 centimeters long was taken from the crest of the right tibia. The line of cleavage was outlined with a drill and the removal completed with a chisel. This graft was triangular in cross section and carried periosteum on two surfaces. The base of the tubed pedicle was opened on the radial side by a T incision, the cross incision following the line of junction of the pedicle with the hand and the vertical incision extending proximally along the radial border of the thenar eminence. The stump of the metacarpal was uncovered and the medullary cavity drilled out, the drill hole extending well into the base of the metacarpal. The end of the graft was then shaped with a rongeur to fit the hole. Next, the body of the tubed pedicle was tunneled with a Mayo hæmostat. This permitted the bone graft to be easily slipped into the pedicle and then

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 1. The hand after skin graft was done.
Fig. 2. Photograph of hand after shrinkage of pedicle.
Fig. 3. Photograph of the hand showing the amount of abduction.

Fig. 4. Apposing thumb.

Fig. 5. Holding pin.

Fig. 6. Holding pencil.

Fig. 7. Holding hammer.

Fig. 8. Roentgenogram of hand showing condition of bone graft 9 months after application.

firmly forced into the prepared metacarpal base. The entire hand was immobilized in plaster-of-Paris splint where it remained for 6 weeks. When the splint was removed, bony union of the graft to the metacarpal was excellent.

Passive motion was not resorted to in the after-care, but the patient gradually increased function by voluntary effort. As will be remembered the adductors of the thumb were sutured around the stump of the first metacarpal. Abduction is provided by the extensor ossis metacarpi pollicis and is shown in Figure 3. The patient can readily appose the thumb to the index, middle and ring fingers, as shown in Figure 4.

Figures 5 and 6 illustrate the dexterity of the hand, the first, the picking up of a pin and the second the use of a pencil.

The strength of both the bone graft and the acting thenar muscles are indicated by the use of the hammer, Figure 7. These photographs of function were taken more than one year after the completion of the reconstruction.

Figure 8 is an X-ray picture of the hand taken on January 20, 1926. 9 months after the bone graft was placed. It will be noted that the permeability by X-rays of the graft is almost the same as the permeability of the other bones of the hand. Measurements taken on X-rays at various dates indicate that there has been no demonstrable absorption of the graft.

The fate of bone grafts of this type has occasioned considerable debate but in this case there has been no apparent change. It is of interest to consider that the blood supply to this graft must come from the tubed pedicle which itself has a secondary blood supply obtained through a ring of scar tissue at its base.

Also of interest is the fact that 18 months after completion of the reconstruction, sensation to pin prick was equally acute in all parts of the graft and was also equal in acuity to sensation to pin prick in other parts of the hand. Heat and cold were clearly distinguished but not quite so readily as in the normal.

Asterognostic sense was very limited, probably because of the lack of joint sense.

It will be noted that this thumb is shorter than a normal thumb, but it was so planned, as a thumb of normal length without metacarpophalangeal and interphalangeal joints would not function readily; it would be in the way. This reconstructed member is practically equivalent to a normal thumb amputated at the interphalangeal joint.

X-RAY PELVIMETRY—A SIMPLIFIED TECHNIQUE

By HERBERT THOMS, M.D., F.A.C.S., New Haven, Connecticut
From the Woman's Clinic, Yale University School of Medicine

FOR the past 6 years, I have been interested in using the X-ray as a means of determining the diameters of the superior strait of the pelvis in the living subject. The principles of the method have for the most part been set forth in a previous communication.[1] At the present time, however, the technique has been considerably simplified, and it is the purpose of this paper to describe the procedure which is now employed.

As has been pointed out before, one of the chief essentials is that the patient shall be placed in such a position that the superior strait becomes parallel to the sensitive plate. This is possible when the patient is in a semi-recumbent position, with the back more or less arched (Fig. 1, C).

In order to determine the level of this plane, we identify two points on the external surface of the body; one on the anterior and upper border of the symphysis pubis and the other posteriorly at the depression just below the spine of the fourth lumbar vertebra. An imaginary line between these two points traverses the anteroposterior diameter of the superior strait. For purposes of identification, we usually place a small strip of adhesive over the posterior landmark. This is shown in Figure 2. By means of calipers, we are able to render these two points equidistant from the plane upon which the patient sits, and this is shown graphically in Figure 2. This distance is also measured for purposes to be explained later.

With the patient in position, the tube or target is placed at a distance of 36 inches above the sensitive plate, over a point 5 centimeters posterior to the upper and posterior border of the symphysis. The tube is centered by means of a plumb-line. In our experience, a moderate variation does not materially affect the end-result. Thus, the target or tube may vary 2 or 4 centimeters away from the point above the center of the superior strait, or the superior strait itself may tilt 1 or 1.5 centimeters away from the absolute horizontal and the end reading will not be affected more than a millimeter or so. This amount of leeway makes the method one of practical interest, because of personal variations which may occur.

In the previous communication, a series of calibrated lead strips were used with each plate, to denote the amount of divergence away from the vertical that the rays underwent in their passage from the tube through the patient to the plate. Without further comment on these accessories, we may say that they have been eliminated and in their place a lead sheet substituted (Fig. 1, B). This is a sheet of lead about 1 centimeter in thickness, mounted on a board and perforated in the center with very small holes exactly 1 centimeter apart. Every fifth hole is double, as shown, for purposes of easy reading. The use of this sheet, which is placed in the same plane as the superior strait, is described as follows:

The patient is placed in the position shown, the exposure is made, which varies according to the weight, etc. of the patient, and with the tube and sensitive plate still in position, the patient is removed from the apparatus. The distance of the height of the superior strait above the plane upon which the patient sits having previously been determined with calipers, the lead sheet is placed in the same plane (Fig. 1, A), and another (flash) exposure made on the same plate.

[1] Thoms, H. The clinical significance of X-ray pelvimetry. Am. J. Obst. & Gynec., 1926, xii, 1926.

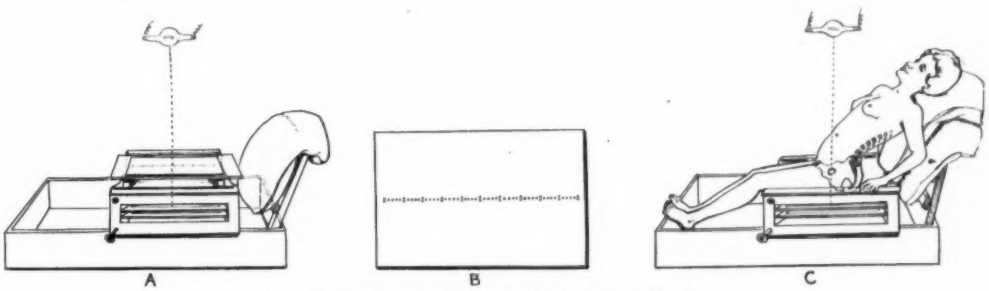

Fig. 1. Diagram of apparatus and of position of patient.

Fig. 2. Adhesive identification tab placed in interspace between fourth and fifth lumbar vertebrae.

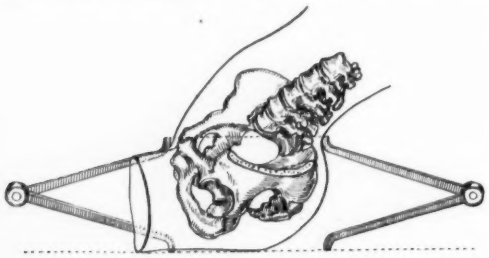

Fig. 3. Drawing showing "leveling" of superior strait by means of calipers.

On developing the plate, an outline of the superior strait is readily seen slightly and equally enlarged, with a series of dots through the plane representing "corrected" centimeters. Any diameter of the superior strait may be measured by this scale and a pair of calipers, and the anteroposterior diameter may be read directly (Fig. 4).

The exposure and other X-ray technique is here repeated: Duplitized superspeed films, a double screen with Bucky diaphragm, and a medium focus Coolidge tube are used. The distance of the target plate is 36 inches. A point spark gap distance of 7 inches—which is equivalent to approximately 65 kilovolts—is employed. The amount of current is 20 milliamperes, and by using an ammeter in filament circuit, this voltage can readily

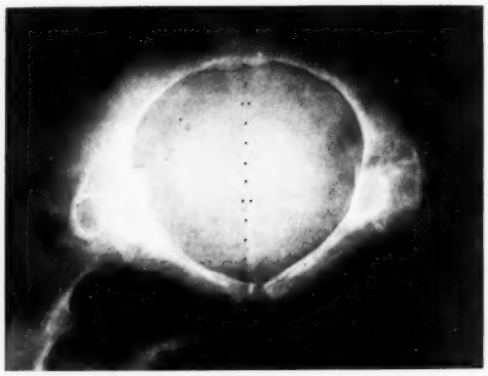

Fig. 4. Pelvigram showing outline of superior strait. Scale in corrected centimeters shown in center (see text).

be obtained without passing the current through the tube. A medium focus Coolidge tube will run easily up to approximately 20 seconds at this setting without greatly overheating. There is no apparent reason why with a heavy patient the tube may not be allowed to cool for 10 or 15 seconds, the patient holding the arched position, with possibly a second setting of the Bucky diaphragm. The time of exposure is as follows:

Pregnant

	Seconds
Thin	16
Medium	20
Heavy	30

Non-pregnant

	Seconds
Thin	10
Medium	14
Heavy	17

Compared with other methods of X-ray pelvimetry, I feel that this procedure is one of unusual simplicity. After the preparation of the lead sheet and the frame upon which the Bucky diaphragm rests, no further mathematical exercise is necessary.

A word as to the use of this method of pelvimetry in practical obstetrics. With us, the method is by no means routine, and is reserved for those cases in which definite information is desired as to the diameters of the superior strait in a given pelvis. This includes those cases in which external measurements show the likelihood of inlet contraction and in those cases at term in which disproportion occurs, or in which the fetal head is floating and cannot be brought into favorable approximation with the superior strait. The usefulness of this method in the classification of pelves and in constitutional studies is apparent.

TUMOR OF THE CAROTID BODY[1]

By E. F. TRAUT, M.D., Chicago

THE carotid body was first described by the school of Haller in 1743. Interest in this structure was revived by Luschka's description in 1862. The carotid body is an ovoid structure about 5 millimeters long, 3 millimeters broad and 1.5 millimeters thick. It is suspended by a mesh of nerves and blood vessels in the bifurcation of the common carotid artery or may be bound to the medial side of that vessel.

No one has improved upon Luschka's histological description. The carotid body consists of alveoli separated by interlacing filaments of nerves, blood vessels, and connective tissue. Within the alveoli, large naked cells are strewn. These cells seem to have no limiting membrane. Their nuclei are large, pale, and vesicular. These cells are regarded as the specific elements in the structure. They contain varying amounts of chromaffin. The walls of the alveoli are richly supplied with medullated and non-medullated nerve fibers and large numbers of ganglion cells. The carotid body is very vascular. It has been called carotid ganglion, glomerulus arteriosus intercaroticus and glandula carotica according as the writer has focused his attention on the nervous elements, the vascularity, or the glandular structure.

Not even the embryologists are in accord on the origin of the carotid body. Smith as well as Arnold (quoted by Klose) regards a convolute of vessels coming from the external carotid as the essential "anlage." The large pale cells in the alveoli then arise from the loose connective tissue forming the investment of the vessels. According to Kohn, the carotid body arises as a collection of large, pale cells originating in the near-by superior sympathetic ganglion. These characteristic cells soon acquire the property of reducing potassium dichromate, a peculiarity of the cells in the chromaffin system. Indeed, the origin and histology of the carotid body is similar in most respects to that of the adrenal medulla. A branch of the external carotid grows out to supply this primitive carotid body with a rich plexus of capillaries.

An endocrine significance has been repeatedly ascribed to the carotid body. Conclusive evidence on this point is lacking. Schmidt noted no effect on removing both carotid bodies from cats. Extirpation of one carotid body did not lead to hypertrophy of the other. Fischer extirpated both carotid bodies from young cats. The bones of these animals developed a condition resembling osteomalacia and the parathyroids hypertrophied. Schmidt reports a case in which tumor formation

Fig. 1. Section of Dr. Davis' tumor. Shows alveolar structure and syncytial arrangement of the "large, pale cells." An occasional giant cell is seen. 100×.

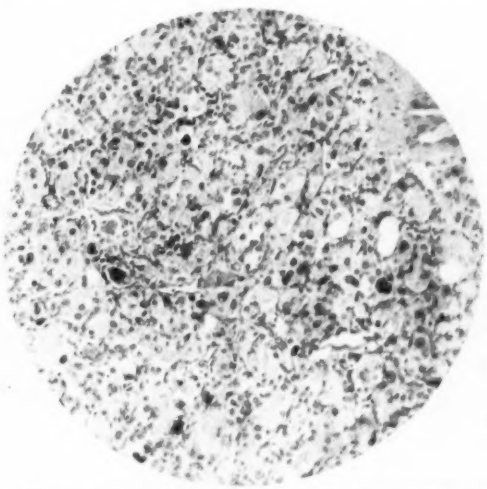

Fig. 2. Section of Dr. Stewart's tumor. Large, pale cells are seen more plainly. The fibrous septa contain capillaries. Several giant cells are visible. 115×.

[1] Read before the Chicago Neurological Society, February 10, 1927.

led to removal of both carotid bodies from a woman 52 years old. There were no ill effects. Klug deflected both carotid glands from the circulation with no other effect than that of trauma. He concluded that the carotid bodies are not necessary to life. According to him, the adrenals and thymus can compensate for the loss of the carotid bodies. Gomez and Frugoni independently injected glycerin extracts of the gland. Gomez saw the blood pressure sink. In Frugoni's animals the blood pressure rose.

Marchand and Paltauf simultaneously and independently first described tumors of the carotid body. Up to the present, about one hundred such tumors have been reported. The lack of agreement in naming the carotid body has been reflected in the naming of carotid body tumors. Because the histology of the tumors is so similar to that of the carotid body itself, Klose prefers Beitzke and v. Gierke's non-prejudicing name of "carotid body struma." In most cases the tumors have been simple hyperplasias of the normal structure or adenomata. Albrecht calls tumors of this sort hamartomata or developmental deformities. He separates them from the true tumors. Marchand, Paltauf, Moenckeberg and Kaufmann call the tumors peritheliomata. According to them the specific large cells crowding the alveolar spaces arise from the connective tissue about the blood vessels. Chiari and Alezais and Peyron said that these cells arise from the endothelium of the vessels. Most of the tumors resemble the normal carotid body histologically. The system of septa and filaments is exactly reproduced. In the alveolar spaces lie the large cells, some taking the chromaffin stain. In a minority of these tumors there are malignant changes. Then the cells are seen infiltrating the capsule and even invading the vessels. Metastases, and these only regional, have been reported in two instances. Gilford and Davis reported three cases of "submastoid potato tumors." These lacked the characteristic vascularity of the true carotid body tumors. They are outspokenly malignant and of doubtful origin. Kaufmann and Moenckeberg exclude these "potato tumors" from the tumors of carotid body.

We have two cases to add to those previously reported.

CASE 1. Our first patient was a married woman 46 years of age. She presented a painless swelling about the size of a hen's egg just anterior to the upper end of the sternomastoid muscle. This swelling was noted 12 years ago following a severe shaking-up in an automobile accident. The only symptom attributable to the swelling was an occasional attack of inspiratory spasm. In the last 3 years this has awakened her several times, compelling her to sit up in bed to breathe. She wished the swelling removed for cosmetic reasons. The swelling was firm, fixed, and pulsated. The patient was otherwise in splendid health. She was not hoarse. The pupils were equal and normal in size. Her pulse rate was 84. The respiratory movements had a normal excursion, 16 to the minute. Dr. H. J. Stewart performed the operation at the West Suburban Hospital. The diagnosis was tuberculous adenitis. The tumor surrounded the carotid bifurcation. The vagus nerve was adherent to it. The tumor, the carotid fork, and about 2 inches of the vagus nerve were resected. Neither the surgeon nor the anæsthetist noted any immediate change in the patient's condition. One hour after the operation, the patient spoke in a low voice. Within 24 hours she had a complete right hemiplegia and aphasia. I first saw her at this juncture. There was a flaccid paralysis of the entire right side of the body, including the face. The blood pressure and urine remained normal. The eye movements were normal. Both discs were equally red. She was fed twice daily by stomach tube. On the sixth postoperative day she developed a bronchopneumonia. She died 22 days after the operation.

Immediately after the operation her pulse was 104 and soon rose to 140. It remained between 140 and 160 until her death in spite of the daily injection of 6 grains of digitalis in the form of digifolin. The digitalis was given not only to sustain the heart but also as a pharmacological experiment. With the resection of the vagus the effect of the depressor nerves was to some extent also removed. If digitalis has a local effect upon the myocardium or the vagus endings the pulse rate should have fallen. On the contrary, it remained unaffected, giving further support to the belief that the digitalis effect is due to stimulation of the vagus center and requires an intact vagus nerve.

Autopsy disclosed a purulent bronchitis and bilateral bronchopneumonia. There was a minimum of arteriosclerotic changes in any of the vessels. The vessels at the base of the brain were all present and normally arranged. The left cerebral hemisphere was larger, softer, and more cyanotic than the right. There were extensive areas of encephalomalacia especially in and about the internal capsule.

Histologically the tumor consists of a connective-tissue core, framework, and capsule inclosing the alveolar spaces. In these spaces are scattered large nuclei in homogeneous cytoplasm. Parallel connective-tissue fibers poor in nuclei form the capsule. The capsule is well supplied with wide, thin-walled vessels. Interlacing fibers from the capsule mark off more or less round cell nests. They then course in a more or less central direction to unite into a heavy fibrous trunk. Whole groups of cell nests are again surrounded by somewhat heavier fibrous partitions. That part of the tumor immediately under the capsule is richest in cells. The cytoplasm in the cells is homogeneous and without walls. In some places cell boundaries seem to be visible. This may be an artefact of the fixing process. The nuclei are usually oval and are well demarcated. Each nucleus contains one to three necleoli. Giant cells of the type termed "tumor giant cells" with large very dark nuclei are prominent in many parts of the tumor. More uncommon is the Langhans variety with nuclei placed radially and peripherally.

Throughout the tumor there is a diffuse round and plasma cell infiltration of the connective tissue septa. Here and there the infiltration is more or less focal. In the center of such foci, the tumor tissue is faded and structure is blurred. Many polymorphonuclear forms are seen in such areas. Small hæmorrhages are common. These are evidently spots of necrosis.

The vessels of the tumor are principally wide endothelial tubes. In a few cases the endothelium is surrounded by

parallel layers of fibrous tissue. Arterioles with muscular walls are entirely lacking in our sections.

In no place have the tumor cells infiltrated the capsule or perforated a vessel.

CASE 2. In 1920 Dr. Carl Davis removed a tumor of the carotid gland from a laborer 52 years old at the Presbyterian Hospital of Chicago. The man had been aware of the tumor for 3 years. It had been steadily enlarging. It was painful. The patient was hoarse. Pre-operative examination showed a man normal in every way except for a tender swelling, the size of a hen's egg, just below the right ear. There were no abnormalities in the blood count or blood pressure. The larynx was normal. The urine contained a trace of albumin and a few hyaline casts, but no sugar. The tumor was removed from the carotid fork without ligating the vessels nor injuring the vagus. It was necessary to resect the descending branch of the hypoglossal. The patient talked shortly after the operation but was unable to swallow. The day after the operation he was in a stupor. Dr. Bassoe dictated the diagnosis of left hemiplegia and hemianæsthesia due to right cerebral anæmia. The patient died in 5 days of bilateral bronchopneumonia. The histological picture of this tumor is practically the same as that of the previously reported case.

Tumor of the carotid body is usually noticed in the third or fourth decade. It has been seen at 7 years and in a patient of 68. It is usually unilateral. Only two instances of bilateral carotid tumor have been recorded. It occurs as commonly on the right as on the left side and in men as often as in women. When seen by the surgeon it has usually been slowly enlarging for several years. The reason for operation is usually cosmetic. It has rarely been diagnosed correctly before removal. Its growth is usually slow. Metastases are rare and then only to the regional lymph glands. The lack of symptoms from these tumors is remarkable in view of their proximity to important vessels and nerves. In several of the cases, there have been such pressure effects as pain, ringing in the ear and dysphagia.

Objectively they cause bulging of the neck in the region of the carotid fork. The skin over the tumor is freely movable. The tumor itself can be moved from side to side but not vertically. The surface is usually smooth. Continuous pressure gradually decreases the size of the tumor by squeezing out the blood. The tumor usually pulsates. There is usually a thrill and a bruit. Large carotid tumors bulge into the pharynx. By involving the superior laryngeal nerve it may cause vocal cord paralysis or spasm.

When first seen they are usually considered carotid aneurisms, enlarged lymph glands, or branchial cysts.

The only treatment is surgical. It has been necessary to resect the internal carotid or all other carotids in 70 per cent of the reported cases. Seventeen per cent of these cases developed hemiplegia. The vagus has been resected in 20 per cent of the operations. One-half of these patients have died. Birman gives 29 per cent as the operative mortality. Fifty-three per cent of the patients are more or less disabled after the operation. Only 18 per cent have had an uncomplicated recovery. The best prognosis is given to those patients in whom the tumor has gradually produced more or less occlusion of the carotids. In the opinion of Keen only severe symptoms or rapid growth with suspicion of malignancy can justify an operation fraught with such danger. Preliminary ligation of the jugular has been suggested to prevent the sudden cerebral anæmia consequent upon the ligation of the internal carotid.

SUMMARY

Two new cases of carotid gland tumor are reported.

The histological picture is the same in both. Both have an alveolar structure.

In one patient the carotid arteries and the vagus nerve were sacrificed.

Both patients developed hemiplegia.

Both patients died of pneumonia.

CONCLUSION

Tumor of the carotid gland must be considered when dealing with tumors of the neck.

Indications for operation upon a tumor of the carotid gland must be very imperative.

BIBLIOGRAPHY

BIRMAN. Ueber Strumen der Carotisdruese. Deutsche Ztschr. f. Chir., 1924, clxxxvi, 384.

BOOT. Tumor of the carotid gland with Stokes-Adams syndrome. Ann. Otol., Rhin. & Laryngol., 1923, Dec.

CHIARI. Beitr. z. klin. Chir., 1912, lxxxi, 599.

DIETERICH. Epithelkoerperchen und Carotisdruese. Beitr. z. klin. Chir., 708, p. 131, 1924.

FISCHER. Ueber die Funktion der Carotisdruese. Ztschr. f. d. ges. exper. Med., 1924, cdixxvii, 39.

GUTHRIE. Tumor of the carotid body. J. Laryngol., London, 1924, xxxix, 635.

HARTTUNG. Carotisdruesentumor. Beitr. z. klin. Chir., 1924, cxxxi, 142.

KEEN'S SURGERY. vol. iii, ed. 1911, p. 307.

KAUFMANN and RUPPANNER. Ueber die alveolaren Geschwuelste der glandula carotica. Deutsche Ztschr. f. Chir., 1905, lxxx, 259.

KLOSE. Beitrage zur Chirurgie der sog. Carotisdruese. Arch. f. klin. Chir., 1922, cxxi, 689.

KLUG. Ueber die Carotisdruese. Beitr. z. klin. Chir., 1924, cxxxi, 531.

MILLER and GARLAND. Tumor of the carotid gland. Boston M. & S. J., 1924, cxxci, 659.

MOENCKEBERG. Beitr. z. path. Anat. u.z. allg. Path., 1905, xxxviii, 1.

REID. Adenomata of the carotid gland. Bull. Johns Hopkins Hosp., 1920, clxxvii, 31.

ROYSTER. Tumors of the carotid body. South. M. J., 1924, xvii, 196.

SCHMIDT. Beitraege zur Kenntnis der glandula carotica und ihrer Tumoren. Beitr. z. klin. Chir., 1913, lxxxviii, 301.
SIMMONDS. Paraganglion intercaroticum. Deutsche. Med. Wchnschr., 1913, xxxix, 1337.
SMITH. Origin and development of the carotid body. Am. J. Anat., 1924, xxxiv, 87.
VAN BOGAERT. Paraganglioma carotidien bilateral. Bull. de l' assoc. franc. p. l'etude du cancer, 1924, xiii, 307.

THE PRE-OPERATIVE MANAGEMENT OF PATIENTS WITH HYPERTHYROIDISM

BY A. T. BUNTS, M.D., CLEVELAND, OHIO
Cleveland Clinic

PROBABLY in no other group of cases are the strict individualization of the patient and a meticulously observed pre-operative regimen more important than in patients with severe hyperthyroidism. The importance of the pre-operative management of these patients has been stressed increasingly in the literature during recent years but because it is so important it would seem worth while to describe the plan of management carried out in the Cleveland Clinic Hospital.

Although it is true, as stated above, that each patient presents an individual clinical problem, nevertheless the fundamental principles of management are identical and, therefore, it has been found not only convenient but safe to standardize the pre-operative management to a certain extent.

Cases of hyperthyroidism may be divided before operation into three groups: (1) uncomplicated cases; (2) those with cardiac decompensation; and (3) those with extreme toxicity manifested by nausea, diarrhœa, and delirium.

For the uncomplicated case, the pre-operative routine is as follows: The patient is sent at once to bed and remains there throughout the entire pre-operative period. The rest is made as complete as possible; not more than two visitors are allowed at one time, and the visiting period is restricted to one-half hour, twice a day. A complete bath is given daily and a sponge bath at night to induce sleep. Every effort is made to keep the knowledge of the day and hour of operation from the patient in order to prevent, as far as possible, worry and anxiety; and doctors, nurses, and visitors are instructed to co-operate, not only in keeping the knowledge of the time of operation from the patient, but also in inducing a quiet state of mind. The temperature, pulse, and respiration are recorded every 4 hours. The maximum systolic and the minimum diastolic pressures are recorded each morning.

Food substances containing iodine, meat extractives and stimulants are avoided, but the diet is sufficiently ample to satisfy the caloric requirement of the increased basal metabolic rate which characterizes hyperthyroidism. The patient is urged to take liquids, a minimum daily intake of 3,000 cubic centimeters being required.

It should be borne in mind that in every case of hyperthyroidism there is danger of a cardiac complication, even though no signs of cardiac decompensation may be present. For this reason every adult patient is given a course of treatment with digitalis—2 cubic centimeters every 4 hours for 6 doses—unless there is some definite contraindication to the use of this drug. This course is not repeated, unless proper cardiac response, as indicated by good quality and rhythm of the pulse and by a decreased heart rate, has not been secured at the end of 6 or 7 days. In certain cases in which it may be feared that cardiac disturbances may develop after operation, a short course of digitalis is given during the 12 hours immediately preceding the operation.

Of prime importance in the pre-operative management of patients with hyperthyroidism is the use of iodine in the form of Lugol's solution. Every patient with hyperthyroidism is now given 1 cubic centimeter of Lugol's solution in cream three times a day after admission to the hospital, except in cases in which iodine has previously been administered outside of the hospital so that the optimum result has been secured just prior to the admission of the patient to the hospital. According to Graham and Cutler,[1] iodine is just as effectual in cases of hyperthyroidism associated with adenomatous goiter as in cases of hyperthyroidism associated with a smooth, uniform enlargement of the thyroid gland. We also have found this to be true, and both types of patients receive iodine routinely.

[1] Graham, A., and Cutler, E. C. Exophthalmic goiter and toxic adenoma, similarity of response to iodine. Ann. Surg., 1926, lxxxiv, 497–508.

To induce a maximum degree of quiet and of freedom from restlessness and nervousness, 30 grains of sodium bromide are given every night, and if the patient is markedly nervous and apprehensive, one and one-half grains of luminal are given twice a day. Morphine is not indicated in the uncomplicated cases.

Although patients vary greatly in their response to this plan of management, in the average case optimum improvement is secured in from 7 to 10 days and the patient is then considered ready for operation. However, there is no definite criterion whereby to determine the optimum physical condition in any individual patient, and therefore the determination of the optimum moment for operation must depend on clinical judgment based upon increasing clinical experience with these patients. It is certain that in each case the utmost possible degree of mental and physical repose should be gained, and only by constant study of each individual case can it be determined when that moment has been reached.

A patient who appears to be extremely apprehensive and excited, talks rapidly and almost incessantly, with some part of the body always in motion, and is emotionally unstable, is not a good operative risk even though the heart has responded well to treatment and the pulse rate is reduced.

For patients in the second and third groups, which include cases of hyperthyroidism with cardiac decompensation and evidence of extreme toxicity, special care and watchfulness must be exercised both before and after the operation and the pre-operative preparation usually requires a longer period of time than in the first group. Auricular fibrillation and other arrhythmias are not uncommon in patients with hyperthyroidism and normal cardiac action can not always be restored by the use of digitalis. Unless the decompensation in these patients is extreme, they usually stand the operation well. If the effect of cardiac decompensation has progressed to the stage of anasarca, marked improvement may be brought about in many cases by the intravenous administration of novasurol. This pre-operative treatment will even make it possible in some cases to perform lobectomy as the primary operation, when formerly one or two preliminary ligations would have been required.

Of particular menace in cases of hyperthyroidism is the presence of delirium, diarrhœa, and vomiting. In such cases morphine is indicated and should be given in doses of from $\frac{1}{6}$ to $\frac{1}{4}$ of a grain, repeated sufficiently often to secure complete relaxation. In some cases it may be necessary to add $\frac{1}{150}$ to $\frac{1}{200}$ of a grain of scopolamine. These patients are usually dehydrated, and the lack of water should be supplied by the subcutaneous administration of saline solution, 2000 cubic centimeters being administered by hypodermoclysis twice a day. In the case of some delirious patients the transfusion of from 300 to 500 cubic centimeters of whole blood is followed by definite improvement. If the patient can take anything by mouth, fluids are forced, and treatment with Lugol's solution and digitalis is started. If medication by mouth is impossible, iodine is introduced by adding from 4 to 6 cubic centimeters of Lugol's solution to the saline solution for hypodermoclysis, and also by the application of some preparation of iodine to the skin of the abdomen; and the cardiac condition is combated by the subcutaneous administration of digifolin, 1 cubic centimeter every hour for from 5 to 8 doses.

The administration of 500 cubic centimeters of a 10 per cent solution of glucose also is frequently useful in these cases.

By the application of these measures, even the most severe case, if not actually moribund, may be brought to a condition in which the operation may be safely performed, and as stated above, in many cases in which a preliminary ligation would formerly have been considered the essential primary measure, lobectomy is now performed without any severe postoperative reaction.

The keynote to the successful management of the patient with hyperthyroidism is, therefore, knowledge of the effective measures by which to combat each emergency which may arise, together with such a study of each individual case as may make it possible to apply each of these measures in advance of the emergency.

PROBLEMS IN PLACENTA PRÆVIA

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THIS paper is based on a study of 57 consecutive cases of placenta prævia delivered by me or by assistants under my immediate direction. Of this number 2 mothers died; a mortality of 3.5 per cent. There were no deaths from hæmorrhage in the series but both patients succumbed to sepsis.

The gross fetal mortality was 57.9 per cent. The death rate among the babies who might have survived, that is, those who were neither non-viable, monsters, or dead on admission, was 45 per cent. It is evident therefore that with a low maternal mortality an unduly large number of infants were lost. Since the methods used to deliver these patients, largely metreurysis and Braxton Hicks version, were aimed solely toward losing as few mothers as possible, the result demonstrates that this may be accomplished. The same methods, unfortunately, which are safest for the mother are the most dangerous to the baby. By a study of these cases and from consideration of the work of others, I am led to conclude that in the future the more liberal use of Cæsarean section in carefully selected cases will save more infants without detracting from the mothers' chances of recovery.

I shall deal first with the diagnosis of placenta prævia, summarize the cases comprising this series, consider in some detail the questions of maternal and fetal mortality, and conclude with an outline of what would appear to be the rational treatment in each of the varied circumstances accompanying this condition.

DIAGNOSIS

All patients who have bled at all in the second half of pregnancy should have a thorough vaginal examination under an anæsthetic. Since in its initial stages the bleeding from placenta prævia is often very slight, it is imperative to investigate all losses of blood of whatever degree. The vast majority of visible hæmorrhages from the fifth lunar month on are due either to placenta prævia or to premature separation of the normally implanted placenta, both conditions of the utmost gravity. Since the treatment of the two conditions is not always the same, it is essential that the obstetrician should distinguish between them.

At the Boston Lying-in Hospital all patients who have bled are at once admitted. They should never be examined in their homes or even in a pregnancy clinic but only under circumstances suitable for the aseptic induction and conduct of labor should it be found necessary. Moreover, a brisk hæmorrhage is sometimes set up by the manipulations of making the diagnosis. Since this may be the case, the obstetrician should never find himself in the embarrassing position of being unable immediately to cope with such a situation. Accordingly, on admission to the hospital the patients and their husbands sign an operative permit authorizing us to terminate pregnancy or to perform any surgical operation that we may consider necessary. Voorhees bags and instruments for their insertion are sterilized and at hand. The patient is taken to a delivery room, anæsthetized with nitrous oxide and oxygen, and examined under the strictest aseptic precautions. The whole hand is introduced into the vagina and a finger is for its entire length inserted through the cervix. The finger is swept around the whole circumference of the lower uterine segment. If the placenta is felt, the diagnosis is evident. Should the placenta not be felt and if ablatio placentæ, hydatidiform mole, and an intra-uterine tumor can be ruled out, then the cause of the bleeding must be sought elsewhere. A speculum is introduced and the cervix viewed. In many cases bleeding erosions will be disclosed; less often a cervical polyp may be present.

The most common error in the diagnosis of placenta prævia is lack of thoroughness in examination. On several occasions the condition has been overlooked by members of the hospital staff because they did not anæsthetize the patient, insert the hand into the vagina, insinuate the finger through the cervix, and explore the whole region of the uterus within its reach. I have never known the diagnosis to be missed when this routine has been carried out.

Since it is our belief that there is no expectant treatment for placenta prævia, once the diagnosis is made the obstetrician sets about the termination of pregnancy by the most appropriate means, regardless of the viability of the child. In the past some have advocated that when the fetus had not quite reached the period of viability the patient should be put to bed until

the infant had developed sufficiently to stand a fair chance of survival. We believe that such an experiment is a dangerous one. Too often a furious hæmorrhage has ensued even when the patient was in a well equipped maternity hospital, with the result that the baby was not saved and the mother's life needlessly endangered. In placenta prævia it is better to take no unnecessary chances with the mother's life and at this stage of pregnancy to disregard the baby. It is better to wipe the obstetrical slate clean. If the patient lives she may have another child.

It is obvious that the technique of diagnosis as just outlined is a matter for the obstetrical specialist and should be carried out in a proper hospital. The general practitioner, faced with a case of bleeding in the second half of pregnancy, will best serve the interests of his patient *if he makes no vaginal examination whatever* and sends her to the nearest hospital if there is one available. Until all preparations are made for treatment, the diagnosis is of relative unimportance, and it is the bleeding that is the outstanding feature. Especially will the local physician do his utmost to insure the patient's recovery *if he refrains from packing the vagina*. This pernicious act as performed outside the hospital practically never stops the bleeding and as it is usually done hastily by a poor light and without due regard for asepsis it only invites infection. Ballhorn (1) states that 20 per cent of the cases that have been tamponed at home develop puerperal sepsis.

TYPES

Of the 57 cases, 12 were complete, 16 were partial, and 29 were of the marginal variety. One of the two patients who died had a complete placenta prævia and the other a marginal.

As might be expected, the type of placenta prævia had a considerable effect upon the infant mortality. The percentages of stillbirths and neonatal deaths among viable babies were:

	Per cent
Complete	55.6
Partial	61.5
Marginal	34.8

METHODS OF DELIVERY

Since in the treatment of these cases the primary object was the immediate arrest of the hæmorrhage, the first step was to exert pressure against the placental site either by metreurysis or by Braxton Hicks version. The general policy has been to perform Braxton Hicks version on all cases admitted in desperate condition, as well as on those with non-viable or dead infants, if it were possible to do so. If the cervix were not dilated sufficiently to admit two fingers for the bringing down of a foot, a Voorhees bag was introduced. Upon the passage of the bag an immediate internal podalic version and extraction was done provided that the os was fully dilated at that time. If full dilatation had not occurred and any cervical edge of any extent whatever remained, the infant was turned, a leg brought down, and the expulsion left strictly to nature.

Cases in good condition with alive and viable fetuses were for the most part treated by metreurysis with the hope that the infant would stand a better chance of survival than by Braxton Hicks version. In about half the cases the bag was placed outside the ovum; in the others it was used intra-ovularly after perforation of the membranes or placenta. The intra-ovular use of the bag has given better results as regards the loss of blood immediately following its expulsion. Perforation of the ovum appears to allow the placenta a better opportunity to retract from the os as dilatation progresses.

Patients with viable fetuses, entering the hospital in active labor and bleeding in whom considerable dilatation had already taken place were treated at once by Braxton Hicks version, since in these patients the cervix is so soft and well dilated that the bag is retained only temporarily.

In no instance was the cervix dilated either manually or by traction on the leg after the baby had been turned. When the bag was used, only enough weight was applied to the stem to check the bleeding. It is to this factor alone that I attribute the absence of any deaths from hæmorrhage. Deaths resulting from hæmorrhage not only on other services in this hospital but also in other clinics I believe to be due to neglect of this precaution. The cervix in placenta prævia is exceedingly soft and friable; it tears with the proverbial ease of wet blotting paper; it should always be treated with the greatest respect. It is a great temptation to the inexperienced and would be spectacular operator to deliver the baby through it *vi et armis*, but if he gives way to this temptation the demise of the patient may be expected promptly. This fact has been known for a very long time, yet in spite of constant reiteration it is still often forgotten. (Table I.)

The two cases delivered by the abdominal route deserve special mention.

CASE 1. Mrs. E. was 30 years old. This was her first pregnancy after 16 years of married life. When 1 week short of term she began to bleed. On examination a breech

TABLE I.—METHOD OF DELIVERY

Method of delivery	Cases	Mothers lived	Mothers died	Infants lived	Non-viable infants died	Viable infants died	Total fetal deaths
Metreurysis followed by							
Spontaneous delivery	7	7	0	1	3	3	6
Low forceps	2	2	0	2	0	0	0
High forceps	1	1	0	1	0	0	0
Breech delivery	3	3	0	1	2	0	2
Version and extraction	18	17	1	10	2	6	8
with craniotomy	1	1	0	0	1	0	1
Braxton Hicks version	6	6	0	2	1	3	4
Primary Braxton Hicks version	12	11	1	2	2	8	10
No artificial dilatation of the cervix							
Version and extraction	2	2	0	1	1	0	1
Mid-forceps	1	1	0	1	0	0	0
Breech delivery	2	2	0	1	1	0	1
Cæsarean section	1	1	0	1	0	0	1
with hysterectomy	1	1	0	1	0	0	0
	57	55	2	24	13	20	33

was found presenting. The cervix was not taken up and was somewhat rigid, the os admitted one finger and the diagnosis of complete placenta prævia was made. A classical cæsarean section was done and a 6 pound living child delivered. The placenta was exceedingly thin and was attached to the entire lower half of the interior of the uterus. There was considerable bleeding attending its removal but neither packing nor transfusion was necessary. Both mother and infant made an uninterrupted convalescence.

The problem that here presented itself was that of an elderly primipara, sterile up to the time of the present pregnancy and exceedingly desirous of a living child. The baby presented by the breech, the cervix was rigid, with complete placenta prævia. Cæsarean section was clearly indicated.

CASE 2. Mrs. M. was a vii-para, at term, with complete placenta prævia. She had been examined vaginally twice before admission by her local doctor with his bare hands. Although she had no elevation of temperature on admission we feared puerperal infection, so profiting by our previous experience we did a cæsarean section and removed the uterus. The uterus, which also contained a large fibroid, was delivered unopened through the abdominal incision and carefully walled off. It was incised and a living child weighing 7 pounds and 5 ounces was extracted. After a change of gloves, drapery, and instruments the uterus was amputated above the cervix. The os was left open and a cigarette drain led through it into the vagina. Another drain was placed to the pelvis through the abdominal wound. After a febrile convalescence of 25 days, caused in part by mild pelvic infection and in part by pyelitis, the patient was discharged well with her baby.

This patient had already borne 6 children. The uterus had served its purpose as a reproductive organ and since its retention would have invited grave danger of infection and possibly death it was deemed good judgment to remove it.

Simple rupture of the membranes as a means of treating marginal placenta prævia was not done in any case. Ballhorn (1) states that in his cases so treated there was no maternal death. Watson and Miller (26) report 61 cases of marginal placenta prævia treated in this way, with a vaginal pack, or with a vaginal pack followed by forceps, with one maternal death. The fetal mortality in this group, however, was 41 per cent. Burgess (4) reports an infant death rate of 42.3 per cent following simple rupture of the membranes. It would appear that this method, while safe for the mother, offers no advantages over metreurysis so far as the baby is concerned.

HÆMORRHAGE FOLLOWING DELIVERY

More than the usual amount of bleeding immediately postpartum occurred 10 times in the 57 cases. It was mild four times, moderate four times, and severe twice. Expression of the placenta rather than manual extraction has been the rule, since it is our policy to invade the uterine cavity only for sufficient cause. It was necessary to pack the uteri of 7 patients for postpartum bleeding, and this procedure was carried out twice on the same patient. The uterus is never packed as a routine since we believe that in all cases, and particularly in placenta prævia, it predisposes to infection.

TRANSFUSION

Three patients were subjected to transfusion; one of them twice. Transfusion is occasionally a life-saving adjunct in the treatment of placenta prævia. All patients with this condition should be grouped immediately on entrance to the hospital and a suitable donor should be held instantly available until his services are no longer needed. We use the citrate method entirely as it is simple and certain. In the exsanguinated cases a transfusion should be done at once, a Braxton Hicks version performed to check further blood loss, and the transfusion repeated if necessary.

CONVALESCENCE

The puerperium was afebrile in 45 cases; febrile in 12, or in 21 per cent. Five of the 12 febrile cases, including the 2 that died, were frankly septic. In the series of 168 cases delivered by all methods and reported by von Mikulicz-Radecki (17) there was a morbidity of 46.6 per cent, in Bauer's (2) series 31.5 per cent, in Heinlein's (8) 16 per cent, and in Wagner's (25) 22 per cent. Hitschmann (9) says that the mortality from sepsis in cases of placenta prævia is 10 times as great in hospitals and 20 times as great in homes as in cases of the normally situated placenta. It is evident that infection of either a mild or severe degree may be expected in 1 case out of 4. Sepsis may result from examinations made under poor conditions outside the hospital,

TABLE II.—MATERNAL AND FETAL MORTALITY ACCORDING TO VARIOUS AUTHORS

	Cases	Per cent maternal mortality	Per cent fetal mortality, viable and non-viable	Per cent fetal mortality, viable
Metreurysis				
Schweitzer (collected)	670	5.80	——	27.60
Depken	116	3.50	——	38.80
Braxton Hicks version				
Montreal Maternity Hospital (Burgess)	21	——	80.95	——
Schweitzer (collected)	1,266	5.40	——	79.40
Rotunda Hospital (Jellett)	138	3.69	——	——
Hoffmann, Behm, Lomer	178	4.50	——	——
Depken	26	15.40	50.00	——
Duesseldorf Clinic (Schoenholtz)	51	5.90	——	35.00
Stratz (personal cases)	110	0.90	64.00	——
Cæsarean section				
Edinburgh Royal Maternity (Watson and Miller)	14	7.20	7.20	——
Kiel Clinic (von Mikulicz-Radecki)	31	3.30	21.90	——
Montreal Maternity Hospital (Burgess)	12	16.67	33.34	——
Karlsruhe Clinic (Wagner)	18	5.50	22.20	——
Siegel (collected)	528	6.30	——	6.80
Schulte	25	——	——	12.50
Depken	11	9.00	——	——
Duesseldorf Clinic (Schoenholtz)	48	4.10	10.40	6.50
All methods				
Malmö General Hospital (Bauer)	185	2.20	——	——
Charity Hospital (Miller)	40	20.00	54.00	28.00
Karlsruhe Clinic (Wagner)	172	9.30	52.90	——
Lieberman	79	13.79	64.55	——
Boston City Hospital (Lynch)	92	19.56	55.00	25.00
New York Lying-In Hospital (McPherson)	591	12.10	60.00	——
Chicago Lying-In Hospital	70	1.30	28.00	12.80
Johns Hopkins Hospital (Thompson)	66	10.60	72.90	——
Depken	204	9.40	58.10	——
Metreurysis, Braxton Hicks version, extraction after full dilatation				
Schulte	52	5.77	33.34	——
Boston Lying-In Hospital (Kellogg)	151	8.20	——	——
Vaginal cæsarean section				
Doederlein	159	8.20	——	17.00
No interference or rupture of membranes (mostly in marginal placenta prævia)				
Edinburgh Royal Maternity Hospital (Watson and Miller)	61	1.63	41.00	——
Montreal Maternity Hospital (Burgess)	52	1.92	42.30	——

by the introduction of a foreign body to check the bleeding, such as the vaginal pack or even the metreurynter or by free access to the low-lying placental site of the pathogenic bacteria which may be found in the vagina postpartum. Infection is aided by the anæmia and lowered resistance of the patient. If, as some advocate, cæsarean section should be adopted as the method of choice in placenta prævia, all danger from the bag as a foreign body and the manipulations necessary to bring down a leg in doing a Braxton Hicks version would be avoided, but the other factors would still remain. Since sepsis following cæsarean section is considerably more fatal than that consequent to pelvic delivery it is evident that cases to be delivered abdominally must be selected with great care, if it is planned to leave the uterus *in situ*.

MATERNAL MORTALITY

Most deaths in placenta prævia result from hæmorrhage, sepsis, or shock. Since the practice of accouchement forcé has been abandoned, deaths from shock have vanished with it. The 2 patients in this series who were lost, died from sepsis.

CASE 1. Mrs. D., viii-para, entered the hospital 36 weeks pregnant with a complete placenta prævia. She had been examined twice before admission by her family doctor. She was anæsthetized and the cervix found to be 4 fingers dilated. A Voorhees bag was introduced outside the ovum. After the bag had passed the cervix some hours later the os was found to be fully dilated and the fetus was delivered by version and extraction. The infant weighed 5 pounds 12 ounces and survived. There was no hæmorrhage following delivery and the uterus was not packed. The patient developed puerperal sepsis and died on the twenty-ninth day postpartum.

CASE 2. Mrs. S., vii-para, entered the hospital with a marginal placenta prævia in the thirty-ninth week of pregnancy. The membranes had ruptured outside. The family doctor had examined the patient before admission and had packed the vagina with cotton. At the time of admission, the temperature was 102.3 degrees and the pulse 140. A Braxton Hicks version was done, and the infant, which weighed 6 pounds and 12 ounces and was somewhat malodorous, was later expelled spontaneously. There was no hæmorrhage following delivery. A stormy septic convalescence ensued. A gluteal abcess was opened and drained, a sacral abscess was opened and drained, and finally a pelvic abscess was incised by vagina and the pus evacuated. In addition to the usual supportive treatment she received two transfusions of 500 cubic centimeters, one on the nineteenth and the other on the thirty-fourth day. She died on the thirty-ninth day of the puerperium.

It is my opinion that the first patient and possibly the second could have been saved had the abdomen been opened, the uterus eventrated, and a cæsarean section with hysterectomy and free drainage done. The principle of removal of the uterus, first advanced by Porro, has been successfully applied to many infected cases in which the placenta was in its usual situation but which had been subjected to fruitless attempts at delivery from below. With the extra liability to sepsis which is known to exist in placenta prævia, there is every reason to employ this method when potential sepsis is present. (Table II.)

Reported mortality statistics in placenta prævia, like similar figures in any obstetrical condition, should not always be taken at their face value. Most of them are a compilation of the results of a number of operators working in the same institution, but not always under the same policy, and subject to variations in judgment and operative skill. Outstanding among the results published up to the present are those of Stratz (23), who reports the loss of one mother

in 110 cases, mostly from private practice, which he personally delivered, giving a mortality of 0.9 per cent. So far as I am aware this figure has never been equalled in a series of equal size. Practically all of his cases were treated by Braxton Hicks version, a convincing argument for the safety of this operation. Without wishing to detract in the slightest degree from the credit due him, one cannot help but remark in passing that all omens must have been favorable. It is, however, noteworthy that his gross fetal mortality was 64 per cent, which gives an equally good picture of the usual effect of this treatment upon the infants.

Hospital statistics also vary as regards the type of patients admitted to its wards. The New York Lying-In Hospital maternal mortality, 12.1 per cent, compiled by McPherson (16), represents a large number of neglected cases already infected or exsanguinated before admission. The clientele of the Boston Lying-In Hospital is similar to it. On the other hand the record of the Chicago Lying-In Hospital (5) of a maternal mortality of 1.3 per cent in 70 cases of placenta prævia for the 7 years ending in 1925 is understandable in view of DeLee's statement that over three-quarters of its patients come from the better classes of society.

A glance through Table II reveals a considerable variation in the percentages of maternal mortality, part of which is no doubt due to some of the factors noted above. However, Braxton Hicks version and metreurysis show consistently the best results for the mother, and the mortality following the extended use of either should not exceed 5 per cent. Cæsarean section exhibits a slightly higher death rate, the 6.3 per cent mortality in the 528 cases collected by Siegel (22) being probably a fair representation of the true state of affairs. The employment of all methods of delivery shows great variations, from 1.3 and 2.2 up to 20 per cent. This discrepancy does not indicate, however, that all cases of placenta prævia should be treated in some one way. No one measure, cæsarean section, Braxton Hicks version, or metreurysis, is applicable to all patients. In no other situation in obstetrics is the demand for mature judgment more pressing. All factors in every case should be weighed and the individual treated accordingly.

FETAL MORTALITY

Of the 57 infants, 12 were non-viable or dead on admission and 1 was an anencephalic monster. There were 20 viable babies that were stillborn or that died in the hospital. The gross fetal mortality was therefore 57.9 per cent and the corrected mortality 45 per cent. Since metreurysis and Braxton Hicks version were the methods of choice, a high fetal mortality was to be expected. In this series the mortality among viable infants delivered by metreurysis was 41.4 per cent; by Braxton Hicks version, 80 per cent. (Table II.)

It is evident that Braxton Hicks version is accompanied by the highest infant mortality and that the selection of this form of delivery practically means the sacrifice of the child. If the fetus is already dead, non-viable, or a monster it need give us no further concern. Therefore in such cases Braxton Hicks version is clearly indicated because it has the lowest reported maternal mortality, provided that the patient is uninfected and the cervix sufficiently dilated to admit 2 fingers so that a foot may be grasped. It is also the best operation for the general practitioner without hospital facilities as it requires no special equipment. He should remember, however, that having turned the baby, its expulsion must be left to nature, otherwise he will tear the cervix and is likely thereby to cause fatal hæmorrhage.

I cannot agree with the statement of Siegel (22) that cæsarean section is the best treatment for placenta prævia, after the thirty-second week of pregnancy, regardless of whether the child is dead or alive. If the patient is uninfected and the baby dead, Braxton Hicks version will in the long run give the best result for the mother. If the patient is potentially infected, cæsarean section followed by hysterectomy is the logical procedure. I also for the same reasons disagree with Kellogg's (12) statement that all cases of central and partial placenta prævia are best treated by abdominal cæsarean section whether the baby be viable or non-viable, living or dead.

SUMMARY

1. A series of 57 personal cases of placenta prævia is reported. Two mothers died from sepsis, giving a maternal mortality of 3.5 per cent. There were no deaths from hæmorrhage.

2. The gross fetal mortality was 57.9 per cent. Eliminating non-viable infants, monsters, and those dead on admission, the corrected mortality among viable infants was 45 per cent.

3. The methods of delivery used for the most part were metreurysis and Braxton Hicks version. In no case was the cervix dilated forcibly, either manually or by traction on the fetus. Two cæsarean sections were done and one was followed by a hysterectomy.

4. Removal of the placenta by expression was the rule. The uterus was packed 8 times in 7 patients. Avoidance of unnecessary intra-uterine manipulation postpartum is desirable.

5. The morbidity rate was 21 per cent.

6. Deaths from hæmorrhage in placenta prævia may be avoided by adherence to three cardinal rules: (1) check the bleeding, (2) restore excessive blood loss by transfusion, and (3) respect the cervix.

7. Sepsis is responsible for a considerable number of deaths in this condition. Cæsarean section followed by hysterectomy is indicated if the patient is potentially infected.

8. In view of our present knowledge the ideal treatment of placenta prævia may be stated as follows:

If the patient is uninfected and her condition poor from loss of blood she should receive a preliminary transfusion. A Braxton Hicks version should be done forthwith regardless of the state of the infant, because it is the quickest way to stop the hæmorrhage.

If the patient is uninfected and her condition good but the baby dead, non-viable, or a monster, she should also have a Braxton Hicks version because it has the lowest maternal mortality and the baby in this case need not be regarded.

If the patient is uninfected and her condition good and the baby alive, normal, and of sufficient size to warrant the assurance of survival, cæsarean section should be done, as in this way the baby will be saved and the mother's life not unduly jeopardized.

Simple rupture of the membranes in marginal placenta prævia is safe for the mother but no better than metreurysis for the baby.

If the patient is potentially infected she should be delivered by cæsarean section followed by hysterectomy regardless of the state of the baby. If she is in poor condition, a transfusion is given prior to operation.

BIBLIOGRAPHY

1. Ballhorn, W. Arch. f. Gynaek., 1925, cxxiii, 646.
2. Bauer, G. Acta gynec. Scand., 1924, iii, 236.
3. Behm. Ztschr. f. Geburtsh. u. Gynaek., 1883, xiv, 373.
4. Burgess. Am. J. Obst. & Gynec., 1925, x, 49.
5. Chicago Lying-In Hospital. Statistical Report of, Kennedy Strean and Harries, 1925.
6. Depken, H. Zentralbl. f. Gynaek., 1924, xlviii, 298.
7. Doederlein, A. Muenchen. med. Wchnschr., 1922, lxix, 123.
8. Heinlein, F. Zentralbl. f. Gynaek., 1922, xlvi, 170.
9. Hitschmann. Die Therapie der Placenta prævia. Berlin: Karger, 1921.
10. Hoffmann. Winckel's Handbuch, 1904, ii, 1198.
11. Jellett. Lancet, 1910, i, 1271.
12. Kellogg, F. S. Am. J. Obst. & Gynec., 1926, xi, 194.
13. Lieberman, B. L. Am. J. Obst. & Gynec., 1926, xi, 814.
14. Lomer. Am. J. Obst., 1884, xvii, 1233.
15. Lynch, F. J. Boston M. & S. J., 1924, cxc, 631.
16. McPherson, R. Am. J. Obst. & Gynec., 1924, vii, 403.
17. Mikulicz-Radecki, von. Arch. f. Gynaek., 1925, cxxiii, 245.
18. Miller, C. J. New Orleans M. & S. J., 1925, lxxvii, 370.
19. Schoenholtz, L. Monatschr. f. Geburtsh. u. Gynaek., 1912, 794.
20. Schulte, J. Zentralbl. f. Gynaek., 1924, xlviii, 1065.
21. Schweitzer. Zentralbl. f. Gynaek., 1912, 794.
22. Siegel. Monatschr. f. Geburtsh. u. Gynaek., 1926, lxxiii, 18.
23. Stratz. Ztschr. f. Geburtsh. u. Gynaek., 1915, lxxvi, 713.
24. Thompson, W. B. Bull. Johns Hopkins Hosp., 1921, xxxii, 228.
25. Wagner, H. Ztschr. f. Geburtsh. u. Gynaek., 1926, lxxxix, 605.
26. Watson, B. P., and Miller, D. Tr. Edin. Obst. Soc., 1924–1925, lxxxiv, 55.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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THE GENTLE TOUCH IN SURGERY

THERE are few of the arts and sciences that show, in the last 50 years, greater changes and advancement than surgery. Speed in operating, while always essential for safety and an asset to the operator, does not hold the same relation to good results that it did in pre-anæsthetic days. But ask any surgeon himself and he will tell you he prefers, for his own person, a speedy operator *provided* the man is not rough, is careful, and does not omit any of the technical necessities. Is it not painful to watch some operators fussing at their work and spending not only the patient's cash but his vitality over non-essential technical details? Speed in operating comes first from knowledge, but chiefly from experience and practice. It stands to reason that after one has performed a thousand gastro-enterostomies, his subsequent work will go off with greater dispatch than it did while he was performing his first dozen operations. But there is no escaping that first dozen! There is, however, an additional element to be considered, which is frequently overlooked. That element is temperament. With this you are endowed at birth. Exactly as some men are quicker at figures than are others, and also as some are quick to catch the point of your talk, so some are quicker in their mental processes and their movements. Some are like highly organized racehorses, constantly strung up on the *qui vive*, and figuratively always working "on their toes." They may do this possibly at a wasteful expenditure of energy (to themselves), but these men are often our great surgeons and they "deliver the goods."

There is one quality in surgical work that is often forgotten. That quality is *gentleness!* Gentleness before and after the operation is, of course, in the nature and work of every good surgeon. That goes without speaking. But do we not, after our patient is under the anæsthetic and unconscious, fail to remember what Crile has for so many years tried to teach us? Yes, surely our patient is asleep. He gives no outward evidence of traumatic injury. But his tissues and nerves are still very much on the job, and resent in their own silent but positive way their insult and injury. A stupid surgeon does not see this. He will place a hoe-like retractor in an abdominal wound and pull on it with almost his whole strength and traumatize the edges while pulling the wound apart. It is true the peritoneum is long suffering. It will stand much abuse. It will even be *forgiving*, and after the operation is over, with the help of God it will even digest a foreign insult. But the wise surgeon remembers that the peritoneum is his best friend. And who would injure his best friend? Watch two men with equal ability

doing the same class of work. Why is it that one gets almost 100 per cent recoveries both as to morbidity and mortality? Why do the edges of a wound with one surgeon show a tendency to slough so that only the perfect technique of his operating nurse will pull him through without a suppurating wound?

It is often necessary to operate upon the living human body. Probably a well performed surgical operation is one of the finest and greatest works of man. Do painting, or sculpture, or architecture, business, or even divinity require a nicer or a gentler touch?

It often takes years to teach one just the right amount of tension to put on his sutures. A neglect of this important thing will end in disaster. Who has not seen a hurried and careless surgeon sew up the abdomen as if he were putting a sole on a shoe?

Who as an operator has not sometimes fairly cringed at the rough manner in which an assistant wipes the wound! Do we not know that surgical gauze has a tooth that can bite and tear and scratch?

It takes years to acquire the technique to perform our operations with the *scalpel* and scissors and use as little as is wise and possible what is erroneously called *dry dissection*. The latter is not gentle surgery.

A surgeon is not giving the "gentle touch" when he is doing "stunts." The chief reproach that can be hurled at exhibition operations is that they carry the great temptation to a good man to try to show just how "good" he is. He is working under a strain (although he may not know or acknowledge it). The patient may not get a fair deal.

Without trying to be funny, there is another touch of the surgeon that might be mentioned in passing. That is the touch of his pocketbook. It is an absolutely necessary touch, or else the surgeon would die. Why should this not likewise be gentle? Here, however, comes the rub. What is almost brutal to one patient for the same job is the quintessence of gentleness to another. But notwithstanding the wealth of our patient, we never were bright enough to understand the *comparative* justification in charging from one thousand dollars to two thousand dollars for the removal of the tonsils. There is absolutely no specific instance in the writer's mind; it is only spoken of casually as an example. But there are more like it.

Now the welfare of the patient is our first consideration, not the welfare of our pockets, or our fame as an operator. In order best to conserve that welfare in our surgical work, we must always keep in mind that every wound of the human body is like a sensitive plant. It responds to gentle treatment and resents brutality. It is, moreover, in our own interest to be gentle, for we shall find that we get full compensation for value received: our wounds will heal better, our results will be better, our reputations will be better, and we shall have better satisfaction with ourselves and our work.

In a few words, therefore, we should be gentle-men! JOHN HAMMOND BRADSHAW.

EARLY DIAGNOSIS IN CASES OF TUMORS INVOLVING THE SPINAL CORD

THE promise of Horsley and Gower's work in 1888 has been fulfilled in recent years and improvement in surgical operations on the spinal cord has made rapid strides toward success never dreamed of by these pioneers. The mortality following laminectomy at any level of the spinal axis is lower than it has ever been and results following removal of tumors encroaching on the cord have at times seemed miraculous. Exploration of the spinal canal at any given level is resorted to with much less fear and with more

confidence; it is probably not performed often enough when there is cause to suspect a removable lesion. Greater surgical risks are being faced and convalescence after the operation has been shortened. Nevertheless there remains the most important element in the prognosis in a given case of compression of the spinal cord by a benign tumor, namely the stage at which the condition was recognized and accordingly the degree to which the cord has already been injured. The most brilliantly performed surgical operation can return only as much function to the cord as nature will concede following the removal of pressure; this depends on the length of time it has been present. It is probable that even today many cases of tumors involving the spinal cord are doomed to be unrecognized or, worse still, to be operated on because of some other supposed condition.

A plea is therefore made for early recognition of this disease so that it can be remedied by the very efficient surgical measures now being employed.

The present methods of diagnosis may be considered under two headings, clinical and mechanical. Clinical methods consist of careful history taking, complete physical and neurological examinations and possibly hours of patient checking of the motor, reflex and sensory functions in the area involved. Mechanical aids to diagnosis that have been developed during recent years are the Queckenstedt test, Ayer's differential spinal and cisternal punctures and the use of 40 per cent iodized oil, as suggested by Forestier and Sicard. The older clinical methods are by far the more important, are less subject to fallacies, and not only aim at establishing the nature and exact situation of the cord lesions but also lead to an investigation of the patient as a whole. Further, in spite of all the modern mechanical aids that we possess, this examination of a patient with our five senses cannot be dispensed with.

As a support to the preliminary clinical examination, the Queckenstedt test is simple in its application and extremely valuable in the information it supplies. In all cases in which tumor in the spinal canal is suspected spinal puncture with compression of the jugular veins and manometric readings should be carried out. Failure of the spinal-fluid pressure to respond means a block in the subarachnoid space. The spinal fluid itself has been found to be changed in its physical characteristics below such a block. It may be yellow, coagulate on standing and have a high content in protein (Froin syndrome). Ayer's differential spinal and cisternal punctures represent a further elaboration of the Queckenstedt test and samples of fluid may be obtained and changes in its pressure recorded at various levels above and below the site of the tumor. The use of these differential punctures is of more value when the physical signs are few or misleading, particularly in the case of tumor in the lower dorsal, lumbar, and sacral regions.

With the advent of 40 per cent iodized oil it was hoped that all problems of diagnosis and localization of the lesions would be solved, and in a mechanical and busy age it seemed simplicity itself to inject this substance into the subarachnoid space either above or below the tumor and to locate it directly by the fluoroscope or roentgenogram. Further, it was hoped thus to avoid long and tedious hours of history writing and sensory tests. Unfortunately the drug has been found to possess its own particular fallacies and disadvantages and it now has a much more limited application than was originally hoped for. When clinical examination and differential spinal and cisternal punctures have failed to identify the tumor, or determine its site, 40 per cent

iodized oil can then be used, but the results must be interpreted with due caution. The most perfect results obtained from its use are in cases in which there is a large tumor, a complete block of the subarachnoid space and consequently such marked physical signs that the test is hardly necessary except as confirmation. However, there will always be a small percentage of cases regarding which reasonable doubt exists even after all other methods have failed. This new procedure, therefore, may be regarded as one more aid in the diagnosis and location of growths within the spinal canal.

Increasing surgical skill has made the chapter on spinal cord tumors much more happy reading and a new incentive has been created to separate from the vast medley of incurable diseases of the spinal cord this condition that can be remedied. In the whole realm of medicine there is probably nothing so encouraging and inspiring as our recently acquired ability to restore to normal existence those unfortunate persons who otherwise would be doomed to drag themselves through life crippled, paralyzed and incontinent, dependent on the care of others and useless to society.

H. L. PARKER.

MASTER SURGEONS OF AMERICA

JOHN HOMANS

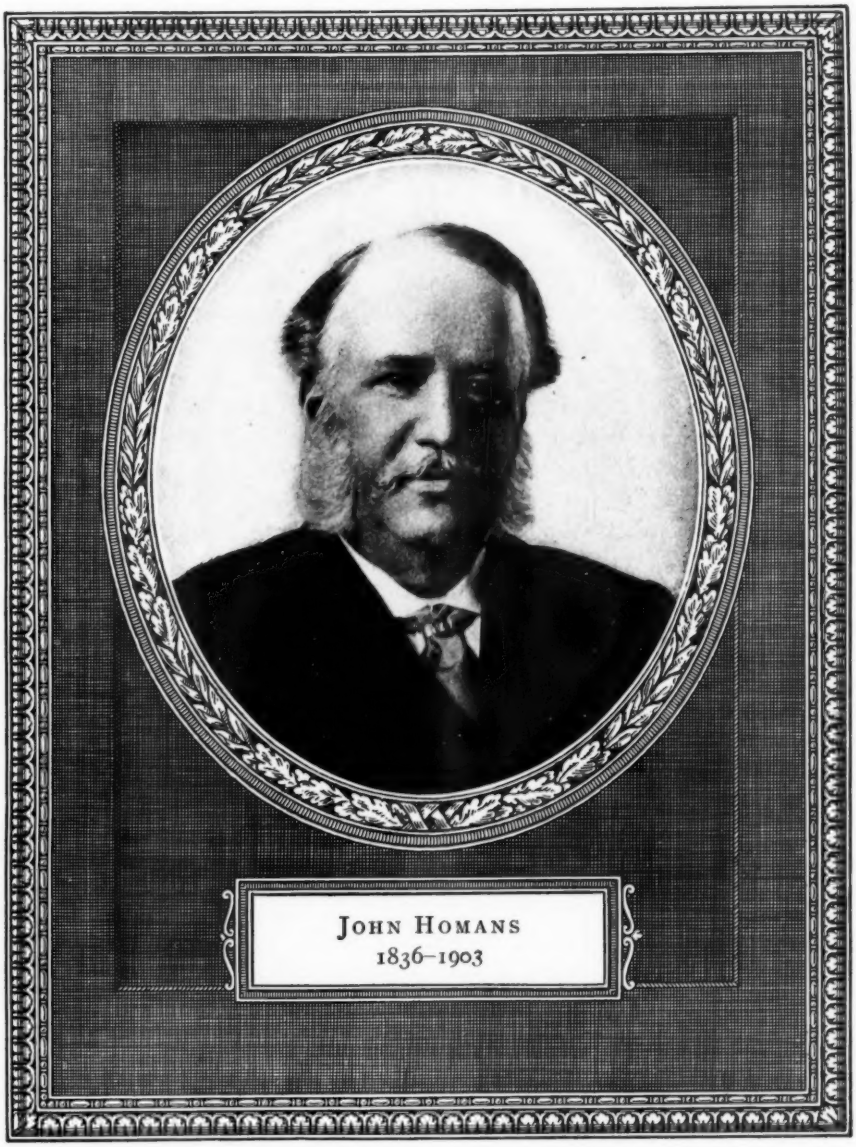
JOHN HOMANS, a distinguished abdominal surgeon of New England, and a pioneer in the use of ovariotomy in this part of the country, was born in Boston, Massachusetts, December 26, 1836. He was the third in direct succession to bear the name. His grandfather, John Homans, who graduated from Harvard College in the Class of 1772, was an army surgeon during the Revolutionary War. He died in 1800, leaving a son, John Homans, who graduated from Harvard College in 1812, received the degree of M.D. in 1815, and practiced medicine in Boston until he died in 1868.

John Homans, the subject of this sketch, graduated from Harvard College in 1858, and received his medical degree from the Harvard Medical School in 1862. He then entered the Massachusetts General Hospital as surgical interne.

His attention was first directed to the operation of ovariotomy by an autopsy which he performed about the year 1860 on a woman who had died with two large ovarian tumors, from which during life she had greatly suffered on account of pressure and dropsy. The experiences and opinions of certain English surgeons furnished added inspiration. He had intended to pursue the matter further, but the Civil War kept his thoughts for 4 years in another direction.

When the Civil War broke out he volunteered for service in the United States Navy, was commissioned assistant surgeon, and served on the *Aroostook* for 6 months; but, although he was much impressed by the care and method of the naval service, he found the confinement on a small vessel irksome, and he had little or no surgery to do there. Finally he succeeded in being appointed assistant surgeon in the regular Army and was ordered to New Orleans where he was assigned for service at the St. James Hospital. To quote from his autobiography[1]: "My duties at the St. James Hospital were very congenial. I had several wards under my care. The cases were mostly affections of the bowels or chills and fever, or malaria in some form, with debility, homesickness, and feebleness from age, the sufferers having understated their age when enlisting. Almost all the members from a Rhode Island battery that came to the hospital were over sixty."

[1] From the address of Dr. George B. Shattuck, at the memorial meeting to Dr. John Homans, held in Boston, March 30, 1903. This quotation, and the one which follows, were taken from the autobiography of Dr. Homans, which, however, was carried only through the first part of his army service. It is a pity that Dr. Homans did not finish recording his war experiences, for, he was very keenly interested in army life, and, of course, he had the opportunity for observing them closely.



JOHN HOMANS
1836–1903

Although, during his service in the army, he naturally had a large number of varied and instructive experiences, it would hardly be appropriate even to enumerate them here. One of his cases, however, is given at length in his own language:

"I had watched another middle aged man, who had been hobbling about the hospital, bent over and leaning on a stick, for about 3 months. He said he had the rheumatism in his back and that he could not stand up straight or do any duty. It seemed to me that the man had better be cured and returned to duty, or discharged. There was no reason why the government should be paying for a man who was of no use. One morning I sent for the sergeant of the guard and told him to send me a strong, sensible man, who could use some judgment in a case for which I should detail him. He sent me a tall Yankee belonging to a New Hampshire regiment.

"I instructed the man to take the afflicted one on to the veranda, to take away his stick and to order him to walk up and down the veranda—if he stopped to prod him with his bayonet. I explained to the patient that I was anxious for his good and wanted to see if I could not cure him. He agreed that it was a sensible plan. In about ten minutes the soldier reported that the patient was walking on the veranda, but was sweating profusely and seemed quite tired. I said: 'Let him up for a few minutes and then keep him going according to your judgment till dinner time, and then take him out again for an hour or so after dinner.' In the afternoon the soldier and the patient reported. The sick man was walking perfectly well and the next day was returned to his regiment. I thought if the man was malingering he would soon repeat the process and get into another hospital. In the autumn of 1864, while surgeon-in-chief of the first division of the 19th Army Corps in the Shenandoah Valley in Virginia, I was hailed by a man on a mule, driving an army wagon. 'God bless your honor, I hope you are well.' 'Very well,' said I, 'and who are you?' 'I am the man you cured of rheumatism in New Orleans, God bless you.'"

In May, 1865, Dr. Homans resigned from the army, after a service, in army and navy together, of somewhat over 3 years.

Not long after leaving the army he went to Europe, where he passed most of his time in studying in Paris and Vienna, and in traveling. He then returned to Boston, November, 1866, and began the active practice of his profession. Within a reasonable period he built up a good family practice; but, as time went on, he was drawn more and more into surgery, of which ultimately he made a specialty, being one of the first physicians in Boston to do so. His experience in the army and navy was an excellent preparation for the life he had chosen; for, while he was in the army he had charge, from time to time, often in the midst of great emergencies, of large numbers of medical and surgical patients for the proper care of whom he was responsible; and, therefore, there were frequent

opportunities for the exercise of rapid judgment and decision in all kinds of cases, as well as for practice in the various operative procedures. He was soon appointed surgeon to the Boston Dispensary, and some years later surgeon to the Children's Hospital, and finally to the Carney Hospital.

It was at the Carney Hospital where he began his long career as an abdominal surgeon that in 1872 he did his first ovariotomy. In 1873 he did a second ovariotomy, and in 1875 a third and a fourth. *His first successful ovariotomy was done in 1877.* Carbolic spray was used for the first time in this operation. The next 4 patients recovered, the spray being used at each operation. That he should have 5 successful operations with carbolic spray, after a number of deaths without the spray, made on Dr. Homans's mind a firm impression; and, although in time, in October, 1887, he gave up the antiseptic method for the aseptic one, he did so with the greatest reluctance. He performed many other ovariotomies at the Carney Hospital, where in 1880 he was made consulting surgeon.

Later, he did his operations at St. Margaret's Hospital, and his cases, of which he always made a careful study, rapidly increased in number. Many were sent to him from different parts of New England, as well as from Boston, and many also from the Provinces. Between 1872 and 1900 he performed 601 ovariotomies; and it is noteworthy that, as his experience increased, his results grew better and better.

His operations were by no means confined to ovariotomies, for he not infrequently opened the abdomen for other purposes. In April, 1881, he began to do abdominal hysterectomies. He was also one of the first surgeons to operate for abscess of the appendix. Many of the details in the operative technique of ovariotomy and hysterectomy in use today, and this statement also applies to certain operations in other parts of the abdomen, were originally devised by Dr. Homans.

"Early in his abdominal work Dr. Homans was appointed surgeon to outpatients at the Massachusetts General Hospital. Not long after this he entered the house as visiting surgeon. At that time abdominal surgery was looked upon as a specialty. By long-established precedent the introduction of specialties into the hospital was not looked upon with favor. For this reason the introduction of abdominal surgery into a general hospital met with some opposition. It is hard to realize that within twenty years abdominal surgery was regarded at the Massachusetts General Hospital as a specialty—a hospital in which more than one thousand abdominal operations were performed in 1901 and 1,155 in 1902!"[1]

As an operator he was conscientious, painstaking, fearless, and usually calm, although somewhat excitable when in a tight place. Occasionally, however, he

[1] From remarks made by Dr. Maurice H. Richardson at the memorial meeting of March 30, 1903.

would have his joke, for he had a strong sense of humor. He took the best of care of his patients after an operation, sparing himself no pains to give them a better chance for recovery, and to make them more comfortable. It may be mentioned that he had been heard to say that the best way to get patients is to take good care of those you already have.

The success of his operations and the earnestness and enthusiasm with which he did his work attracted the attention of the entire profession in this vicinity; and many young men witnessed his operations, or followed his cases, with intense interest, among them being such well-known surgeons as Dr. Maurice H. Richardson and Dr. Arthur T. Cabot. He always kept a list of those persons who were interested in his work, and, after he had made all his arrangements for the operation, he had a notice sent to each one of them. Later some of these young men, stimulated by his example, not only had their own cases of ovariotomy, but applying his methods, extended the area of their own operative procedures to the remotest parts of the abdomen.

Although most of his time was taken up with operating and in attending to his cases, he still was able to do a good deal of writing, and from time to time medical or surgical articles from his hand appeared in the medical journals. In 1887 he published a very important one, entitled: "Three Hundred and Eighty-Four Laparotomies for Various Diseases."

In 1881 he was appointed clinical instructor in the diagnosis and treatment of ovarian tumors in the Harvard Medical School, and for years he lectured there on that subject. Early in his career, he gave a regular quiz course in anatomy (extramural), and this was continued for many years. He was a member of the American Surgical Association, of the Society of the Cincinnati, of which his grandfather was a founder, and of the order of the Loyal Legion. He was also the medical examiner of the New England Life Insurance Company.

He died, after a short illness, at his home in Boston, February 7, 1903, in his sixty-sixth year, leaving a widow and six children, three sons and three daughters. One son, who bears his name, is at present a practicing surgeon in Boston.

Three years after his death the John Homans Professorship of Surgery was established in the Harvard Medical School by his friends and associates. This was indeed a fitting memorial!

In the large number of successful operations which he performed Dr. Homans made a definite contribution to the world; but the real value of his services was especially demonstrated by his leading the way in the development of one of the major operations of the abdomen; and also, by his example, in furnishing the incentive to others to follow in his footsteps.

Members of the medical profession had a great respect for Dr. Homans, and they had a full appreciation of what he had accomplished. He was familiarly

and affectionately referred to as "Uncle John" or as "Honest John Homans." It is refreshing to record the life of a man who possessed so many admirable characteristics. His intelligence, persistence, and courage, his modesty, cheerfulness, and strong sense of humor, when added to those good qualities already referred to, or suggested, combined to make a personality which is as rare as it is attractive.

GEORGE H. MONKS.

THE ANATOMY OF THE HUMAN BODY.

BY
W. CHESELDEN,
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Fellow of the ROYAL SOCIETY
And Member of
The *Royal Academy of Surgeons* at PARIS

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THE SURGEON'S LIBRARY

OLD MASTERPIECES IN SURGERY

By ALFRED BROWN, M.D., F.A.C.S., Omaha, Nebraska

CHESELDEN'S ANATOMY OF THE HUMAN BODY

THE rehabilitation of the teaching of anatomy and surgery in England was due in great measure to William Cheselden. During the seventeenth and early part of the eighteenth century, surgery in England was in a sorry plight. The usual method of training surgeons was by apprenticeships, and when trained, they had difficulty in separating themselves from the barbers. Teaching in London was carried on in St. Bartholomew's and St. Thomas's Hospitals, where the apprentices served seven years and no definite courses were given. The act of 1540, uniting the surgeons and barbers in a single group, was still in effect, and the two groups were almost indistinguishable to the laity, the barbers acting like a millstone about the necks of the progressive and ambitious members of the surgical group. Finally, in 1702, the Governors of St. Thomas's Hospital passed a ruling forbidding pupils or surgeons to dissect without the permission of the treasurer, and a year later the number of apprentices to any surgeon was limited to three.

About this time Cheselden appeared on the scene. He was born at Somerby, Leicestershire, in 1688. He first studied under a surgeon in Leicestershire, and later under the anatomist William Cowper in London, and the surgeon Fern in St. Thomas's Hospital. In 1718 he was appointed an assistant surgeon at St. Thomas's, and in the following year was promoted to be full surgeon. The statement is made by most of the authorities that the first edition of his *Anatomy of the Human Body* was published in 1713, so in the copy illustrated here, which is the sixth edition, the date MDCCXII (1712), must be a misprint and probably should read MDCCXXII (1722). In the title page, Cheselden does not refer to his connection with St. Thomas's, but describes himself as "Surgeon to his Majesty's Royal Hospital at Chelsea, Fellow of the Royal Society, and Member of the Royal Academy of Surgeons at Paris." When St. George's Hospital was founded in 1733, he became one of its surgeons. He died at Bath, England in 1752, living long enough to see the disassociation of the surgeons and barbers for which he had striven all his life, and which took place according to Act of Parliament in 1745.

Cheselden began to teach anatomy, and with it surgery, at St. Thomas's in 1720. His book, although entitled *The Anatomy of the Human Body*, is also in great part surgical; for in it he refers constantly to what might be called surgical physiology, and in places refers to surgical operations. One of Cheselden's great triumphs was his operation for the formation of an artificial pupil by iridotomy, which he describes as "A knife passed through the tunica sclerotis, under the cornea before the iris, in order to cut an artificial pupil where the natural one is clos'd. This operation I have perform'd several times with good success: indeed it cannot fail when the operation is well done, and the eye no otherwise diseas'd, which is more than can be said for couching a cataract. In this operation, great care must be taken to hold open the eye lids without pressing upon the eye, for if the aqueous humour is squeez'd out before the incision is made in the iris, the eye grows flaccid and renders the operation difficult." He also describes an operation for excising a portion of a proptosed cornea, and says: "This operation is very useful, and attended with but little pain."

Cheselden's other great success was in cutting for the stone. In this he was supposed to be supreme, and great stories of his exploits in this operation were told. He is said to have removed a stone by lithotomy in fifty-four seconds. He was at first an exponent of the high operation, but later changed to the lateral perineal section, and improved greatly on the method of Frêre Jacques. He writes in his anatomy a chapter on the history of cutting for the stone, and in it tabulates his results in both types of operation. In the high operation (suprapubic) he "lost no more than one in seven." In his public practice at St. Thomas's he cites two hundred and thirteen cases of perineal section with a mortality as follows: "of the first fifty only three died; of the second fifty, three; of the third fifty, eight; and of the last sixty-three, six. . . . The reason why so few died in the first two fifties was, at that time very few bad cases offer'd; in the third, the operation being in high request, even the most aged and most miserable cases expected to be sav'd by it. . . ."

One of the charming points of this sixth edition is the beautiful copper plates engraved by Ger. Vandergucht, some of which are dissections in the poses of famous statues. The frontispiece represents, according to the author, "the story of Hippocrates going to cure Democrates of madness, but finding him dissecting to discover the seat of the Bile, he pronounced him the wisest man in Abdera."

REVIEWS OF NEW BOOKS

MALARIA is the oldest disease of which we have any reliable record and the most widespread disease in the world today. The paroxysm is largely a neurological phenomenon and very few known nervous system syndromes are absent from the list of conditions arising from malarial infection. So far as the nervous system is concerned, sequels to infection fall into four groups: acute, cachexia, spontaneous recovery or recovery with quinine, and latent forms in which the parasite may live for years in spleen or bone-marrow and emerge only occasionally. Like syphilis, malaria may affect any organ or tissue of the body, but has a strong predilection for the nervous system.

Dr. Anderson[1] presents in a recent volume an enormous amount of original and collected material in a very concise form with extensive tabulation, case histories, and an unusually complete bibliography filling 35 pages. There are a number of good illustrations and four excellent colored plates illustrating brain changes in cerebral malaria.

This volume is the first comprehensive work on the neurological aspects of malaria and is a most valuable contribution. JOHN FAVILL.

A SMALL volume of 200 pages covers the problem of therapeutic malaria[2] in a painstaking manner. A bibliography is appended covering 400 articles which are constantly referred to in the text. As the author says, "general paralysis is a disease in which it is difficult to gauge the value of any treatment, the difficulty being due to the spontaneous remissions which may occur." Nevertheless, if a fraction of the apparent cures are actually attributable to the malaria treatment it should be given a fair trial. The mortality attached to this procedure is frankly presented and analyzed. It is said to be from 2 to 6 per cent. The technique, course, and results are well described. This is a valuable work describing a promising new form of treatment for general paresis. PAUL STARR.

FEDERSPIEL'S[3] ideas of and his experience with cleft lip and palate, with a report of 15 cases, have been published in book form. The first chapter contains a good outline of the history, cause, and development of clefts, three plates of monstrosities with associated cleft lips and probably palates, and the deformities resulting from the Brophy palate operation. The second chapter covers the anatomy and physiology.

Several different methods of harelip operations are outlined including one of the author's for single clefts. The general principles are well laid down and the drawings are clear cut. The author believes that lateral incisions for making palate flaps are unnecessary and cause scar tissue contraction of the soft palate, although they may be made if there is still too much tension after the author's tension plates are in.

Under the non-surgical treatment of cleft palate is a very complete description of various types of appliances and the methods of taking impressions for them. For cases in which a complete closure is impossible, the author closes any available part of the soft palate and the posterior pillars by freshening the edges, drawing them together and suturing them in the midline and then releasing tension by incisions into their substance just below the last suture. The hard palate cleft is then closed with an obturator.

BARRETT BROWN.

A LITTLE book[4] by May on diseases of the eye has gone through so many editions and has been translated into so many languages that it needs no introduction to ophthalmologists. If it is possible to write a book on a specialty for the benefit of students and general practitioners then this little volume fulfils the demands of the almost impossible. The twelfth edition contains much information in an easily accessible and very concise manner. All controversial material has been left out and only well established practice advocated.

VIRGIL WESCOTT.

THE study of angina pectoris[5] by Coffey, Brown, and Humber was stimulated originally by the publication in 1920 of Jonnescu's first operative case. Since making the report of the first series of 5 cases some 30 additional patients have been operated upon by Coffey and a number have been treated by their method and are reported in the present book. The cases are very completely reported and form a mass of instructive material.

The authors conceive of angina pectoris as a spasm of the aorta and coronary vessels which causes death by producing a cardiac asthenia, their view in this case coinciding with that of Daniélopolu.

The surgical treatment is given in considerable detail, illustrated by many full page plates with explanatory pen and ink sketches. This is true also

[1] MALARIAL PSYCHOSES AND NEUROSES, WITH CHAPTERS ON THE MEDICAL, SOCIOLOGICAL, AND LEGAL ASPECTS, AND ON HISTORY, RACE DEGENERATION, ALCOHOL, AND SURGERY. By William K. Anderson, M.D., F.R.F.P.S. (Glas.). New York: Oxford University Press, 1927.

[2] THERAPEUTIC MALARIA. By G. de M. Rudolf, M.R.C.S., L.R.C.P., D.P.H., D.P.M. New York: Oxford University Press, 1927.

[3] HARELIP AND CLEFT PALATE; CHEILOSCHISIS, URANOSCHISIS AND STAPHYLOSCHISIS; HISTORY, ETIOLOGY, DEVELOPMENT, ANATOMY, PHYSIOLOGY, TYPES, SURGICAL AND NONSURGICAL TREATMENT, AND REPORTED CASES. By Matthew N. Federspiel, B.Sc., D.D.S., M.D., F.A.C.S., F.A.C.D. St. Louis: C. V. Mosby Company, 1927.

[4] MANUAL OF THE DISEASES OF THE EYE; FOR STUDENTS AND GENERAL PRACTITIONERS. By Charles H. May, M.D. 12th ed. rev. New York: William Wood and Company, 1927.

[5] ANGINA PECTORIS; THE ANATOMY, PHYSIOLOGY, AND SURGICAL TREATMENT. By Walter B. Coffey, M.D., F.A.C.S., Philip King Brown, A.B., M.D., and John Davis Humber, B.S., M.D. New Orleans: A. J. Dickerson, 1927.

of the gross anatomy of the sympathetic system both craniosacral and thoracolumbar.

The apparent presence of pain conducting fibers in the superior cervical sympathetic ganglion and sympathetic trunk is a distinct addition to the knowledge of this subject.

The book is essentially a collection of data from which one who will may derive a considerable amount of information. It is not written in any dogmatic fashion and credit is given to many sources from which the authors have obtained information. The problem of cardiac pain and the question of the production of angina pectoris and the rationale of the present surgical treatment are still mooted questions which will bear further study.

MICHAEL L. MASON.

DANIÉLOPOLU,[1] professor of clinical medicine at Bucharest and director of the institute of clinical medicine at the Filantropia hospital, has written on the subject of angina for the past 20 years; and although not a surgeon himself has contributed much to the establishment of correct principles in the surgical treatment of the condition. His recent monograph represents the culmination of many years of clinical observation and experimental study. It is written from the standpoint of the physiology of the vasomotor system, especially that of the cardiac nerves. Although developing his own ideas and citing experimental evidence and clinical facts in support of them, he considers critically all other theories and hypotheses that have been advanced in explanation of the condition. It is the most complete and thorough monograph extant on the subject.

The book covers the definition and classification of the anginal syndrome, its symptomatology, clinical course, diagnosis, etiology, pathology and pathogenesis, and treatment. The author believes that angina of both the chest and abdomen is produced by an analogous mechanism, that is, an ischæmia of contractile tissues (the cardiac muscle in the one instance, smooth muscle of the gastro-intestinal tract in the other), the predisposition to which being nearly always an obstructive arterial lesion. He divides angina pectoris into two large groups, the uncomplicated and the complicated. The uncomplicated types he further divides into the organic and the inorganic, and the complicated into those with dyspnœa during the attack and those in which the respiratory embarrassment to an acute pulmonary oedema. In regard to inorganic angina pectoris the author says: "The production of an anginal attack, although most often favored by an organic lesion, is nevertheless a functional trouble due to insufficient vascular supply to the myocardium which may occur without any organic lesion whatsoever." "The attack of angina is to our mind a phenomenon of myocardiac fatigue, in many ways similar to fatigue of voluntary muscle, due to a poisoning of the sensory and motor endings of the myocardium by the products of fatigue. This condition is caused by an insufficient vascularization of the myocardium, a phenomenon which leads to a pressor reflex circle." The object of operative treatment should be to abolish the vicious pressor reflex, which the author believes can be done without danger by a rather simple surgical procedure. In his operation he takes into consideration the fact that the heart requires its nerve supply in order to function properly. He condemns the ruthless removal of nerves without an understanding of their possible function.

MICHAEL L. MASON.

[1] L'ANGINE DE POITRINE ET L'ANGINE ABDOMINALE. By D. Daniélopolu. Paris: Masson et Cie., 1927.

WITHIN the narrow limits of a 61-page brochure, H. Hartmann[2] and his collaborators attempt a description of the early signs and symptoms of malignant disease as it affects the various organs and tissues of the human body. Biopsy illustrations of some of the lesions are given. The booklet is to be recommended in that it helps to focus the attention of the general practitioner upon the problem of the early recognition of malignant disease.

GEORGE HALPERIN.

THE volume on cancers of the breast by Delbet[3] contains 340 pages and a number of splendid drawings from histological preparations. The book represents the results of careful clinical and microscopical studies the aim of which was to correlate the two in an effort to obtain prognostic criteria. It is a fact well known to every surgeon that very early cases may prove rapidly fatal in spite of early and radical intervention, and reversely, apparently far advanced cases may survive for years. Just what constitutes the difference in the relative malignancy of a given breast cancer is what the authors are attempting to establish through their painstaking histological studies of the various forms of breast cancers.

These investigations have convinced Delbet that there are two fairly readily recognizable groups, one of relative benignancy, the other of frank malignancy. To the relatively benign group belong the secreting epitheliomata, epitheliomata characterized by clear cells, these latter least malignant of all, and pavement carcinoma, rare in themselves, rather benign. In the malignant group belong epitheliomata of the hæmophilic type, epitheliomata consisting of independent cells, and third, large cell epitheliomata. The last type of growth is rapidly fatal.

In his own work Delbet was able to establish a correct prognosis in 70 per cent of his cases. On the whole the work is a valuable contribution to our knowledge of the subject and should prove of interest to the surgeon and pathologist alike.

GEORGE HALPERIN.

[2] DIAGNOSTIC DES PRINCIPAUX CANCERS. By Henri Hartmann. Paris: Masson et Cie, 1927.

[3] LES CANCERS DU SEIN. By Pierre Delbet and Mendaro. Paris: Masson et Cie, 1927.

THE recent translation of Rachet's work on gastroscopy[1] was read with much interest. It must be conceded that the art and science of gastroscopy is far from a state of perfection, yet the way has been lighted. The high degree to which bronchoscopy and intrabronchial instrumentation have been developed, leads one to the conclusion that gastroscopy is still in its infancy.

The author describes the instrument and technique perfected by Bensaude, adding his own experience and modifications. The material is scant, the technique is difficult, and the results are far from conclusive, yet the aim is in the right direction. It is quite apparent that many obstacles and difficulties confront the practitioner of this art because of the position and character of the gastric pouch, but it is sincerely hoped that these pioneers in this most interesting branch of diagnosis will not lose courage and will continue their endeavors. J. A. WOLFER.

ABOUT 12 years ago Pilcher published a book on cystoscopy; the many urological advances since that time make Macalpine's *Cystoscopy*[2] all the more timely. Macalpine covers the history of cystoscopy, the mechanics of a cystoscope, the lens system, the pitfalls of cystoscopes and how to trace and correct their faults, the normal bladder (the basis of cystoscopy), the modern interpretation of all forms of cystitis, urinary tuberculosis, syphilis, bilharziasis, trabeculation, and diverticula. The cystoscopy of bladder tumors is described unusually well and is made attractive by the inclusion of a description of the technique of per-urethral diathermy treatment.

The chapter on cystoscopy in prostatic hypertrophy, its indications and dangers, answers many questions which occur to those using the cystoscope infrequently. Attention is drawn to alterations in the bladder due to pregnancy, uterine displacements, and tumors of the uterus. Vesical and ureteral calculi, foreign bodies in the bladder, ureterocele, and the technique of instrumentation are described from the viewpoint of management principally. Cystoscopy in diseases of the kidney, something still too little thought of by the general surgeon, is discussed concisely and evaluated.

This book is highly recommended to anybody who is interested in the study of cystoscopy.

HARRY CULVER.

[1] PRACTICAL GASTROSCOPY. By Jean Rachet, M.D. New York: William Wood and Company, 1927.

[2] CYSTOSCOPY; A THEORETICAL AND PRACTICAL HANDBOOK. By Jas. B. Macalpine, F.R.C.S. New York: William Wood & Company, 1927.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

SURGICAL DISEASES OF THE GALL BLADDER, LIVER AND PANCREAS AND THEIR TREATMENT. By Moses Behrend, A.M., M.D., F.A.C.S. Philadelphia: F. A. Davis Company, 1927.

FISTULA OF THE ANUS AND RECTUM. By Charles John Drueck, M.D., F.A.C.S. Philadelphia: F. A. Davis Company, 1927.

BEITRAEGE ZUR KENNTNIS DER KONGENITALEN HALSFISTELN UND -ZYSTEN. By P. E. A. Nylander. Jena: Gustav Fischer, 1927.

A TEXT-BOOK OF GYNECOLOGY. By James Young, D.S.O., M.D., F.R.C.S. (Edin.) 2d ed. New York: The Macmillan Company, 1927.

THE SCIENCE AND PRACTICE OF SURGERY. By W. H. C. Romanis, M.A., M.B., M.Ch. (Cantab.), F.R.C.S. (Eng.), F.R.S. (Edin.), and Philip H. Mitchiner, M.D., M.S. (Lond.), F.R.C.S. (Eng.). vol. i—General Surgery. vol. ii—Regional Surgery. New York: William Wood and Company, 1927.

GONOCOCCAL INFECTION IN THE MALE. By Abr. L. Wolbarst, M.D. With a chapter written by J. E. R. McDonagh, D.R.C.S. St. Louis: The C. V. Mosby Company, 1927.

EMERGENCIES OF A GENERAL PRACTICE. By the late Nathan Clark Morse, A.B., M.D., F.A.C.S. Revised and rewritten by Amos Watson Colcord, M.D. 2d ed. St. Louis: The C. V. Mosby Company, 1927.

MINOR SURGERY. By Arthur E. Hertzler, M.D., F.A.C.S., and Victor E. Chesky, A.B., M.D., F.A.C.S. St. Louis: The C. V. Mosby Company, 1927.

NASAL NEUROLOGY; HEADACHES AND EYE DISORDERS. By Greenfield Sluder, M.D., F.A.C.S. St. Louis: The C. V. Mosby Company, 1927.

AU SEUIL DE LA CHIRURGIE. By Émile Forgue. Paris: Gaston Doin, 1927.

A TREATISE ON ORTHOPÆDIC SURGERY. By Royal Whitman, M.D., M.R.C.S., F.A.C.S. 8th ed. Thoroughly revised. Philadelphia: Lea & Febiger, 1927.

SURGERY; ITS PRINCIPLES AND PRACTICE; FOR STUDENTS AND PRACTITIONERS. By Astley Paston Cooper Ashhurst, A.B., M.D., F.A.C.S. 3d ed. Thoroughly revised. Philadelphia: Lea & Febiger, 1927.

MANUAL OF SURGERY (ROSE AND CARLESS); FOR STUDENTS AND PRACTITIONERS. By Albert Carless, C.B.E., M.B., M.S. (Lond.), F.R.C.S., and Cecil P. G. Wakeley, F.R.C.S. (Eng.), F.R.S. (Edin.). 12th ed. New York: William Wood and Company, 1927.

INTERNATIONAL CLINICS; A QUARTERLY OF ILLUSTRATED CLINICAL LECTURES AND ESPECIALLY PREPARED ORIGINAL ARTICLES ON TREATMENT, MEDICINE, SURGERY, ETC. Edited by Henry W. Cattell, A.M., M.D., with the collaboration of others. vol. iii. 37th Series, 1927. Philadelphia and London: J. B. Lippincott Company, 1927.

THE TONGUE AND ITS DISEASES. By Duncan C. L. Fitzwilliams, C.M.G., M.D., Ch.M., F.R.C.S. (Edin. and Eng.). New York and London: Oxford University Press, 1927.

THE ESSENTIALS OF OTOLOGY. By George Birmingham McAuliffe, A.B., M.D., F.A.C.S. New York and London: Oxford University Press, 1927.

HEALTHY GROWTH; A STUDY OF THE RELATION BETWEEN THE MENTAL AND PHYSICAL DEVELOPMENT OF ADOLESCENT BOYS IN A PUBLIC DAY SCHOOL. By Alfred A. Mumford, M.D. With foreword by Sir Arthur Keith, M.D., D.Sc., F.R.C.S., F.R.S. New York and London: Oxford University Press, 1927.

THE EAR, NOSE, AND THROAT IN GENERAL PRACTICE; AN INFORMAL GUIDE TO THE MAIN PRINCIPLES. By D. A. Crow, M.B., Ch.B. (Edin.). New York and London: Oxford University Press, 1927.

EVERYWOMAN A NURSE; HEALTH AND NURSING NOTES; FOR THE USE OF NURSING SOCIETIES, TECHNICAL SCHOOL CLASSES, RED CROSS AND AMBULANCE ASSOCIATIONS, ETC., AND IN THE HOME. By Edith Newsome, S.R.N. New York and London: Oxford University Press, 1927.

THE DIAGNOSIS OF PANCREATIC DISEASE. By Robert Coope, M.D., B.Sc., M.R.C.P. New York and London: Oxford University Press, 1927.

TREATMENT OF VENEREAL DISEASE IN GENERAL PRACTICE. By E. T. Burke, D.S.O., M.B., Ch.B. (Glas.). New York and London: Oxford University Press, 1927.

TRAITÉ DE PATHOLOGIE MÉDICALE ET DE THÉRAPEUTIQUE APPLIQUÉE BY PR. ÉMILE SERGENT, L. RIBADEAU-DUMAS AND L. BABONNEIX. Section on Radiologie—Introduction by A. Béclère. Technique des Rayons X Radiodiagnostic by Paul Cottenot. 2d ed. vol. xxxii. Paris: Norbert Maloine, 1928.

ROENTGENDIAGNOSTIK IN DER CHIRURGIE UND IHREN GRENZGEBIETEN. By Dr. Hermann Meyer. Berlin: Julius Springer, 1927.

RECENT ADVANCES IN ANATOMY. By H. Woollard, M.D. Philadelphia: P. Blakiston's Son & Company, 1927.

BIOLOGIE UND PATHOLOGIE DES WEIBES; EIN HANDBUCH DER FRAUENHEILKUNDE UND GEBURTSHILFE. By Josef Halban and Ludwig Seitz. Lieferung 38. Berlin and Wien: Urban & Schwarzenberg, 1927.

PLASTIC SURGERY OF THE ORBIT. By J. Eastman Sheehan, M.D., F.A.C.S. With a preface by Pierre Sebileau. New York: The Macmillan Company, 1927.

A SYNOPSIS OF SURGERY. By Ernest W. Hey Groves, M.S., M.D., B.Sc. (Lond.), F.R.C.S. (Eng.). 8th ed. New York: William Wood and Company, 1927.

PRACTICE OF UROLOGY AND SYPHILOLOGY; A SURGICAL TREATISE ON GENITO-URINARY DISEASES AND SYPHILIS. By Charles H. Chetwood, M.D., LL.D., F.A.C.S. 4th ed. New York: William Wood and Company, 1927.

THE OPHTHALMIC YEAR BOOK. vol. xxiii. Containing bibliographies, digests, and indexes of the literature of ophthalmology for the year 1926. Edited by William H. Crisp, with the collaboration of others. Chicago: Ophthalmic Publishing Company, 1927.

PRACTICE OF SURGERY. Edited by Dean Lewis, M.D., Sc.D. vol. ii. Bones and Joints. Hagerstown: W. F. Prior Company, Inc., 1927.

DISEASES OF THE MOUTH. By Sterling V. Mead, D.D.S. St. Louis: C. V. Mosby Co., 1927.

TONIC HARDENING OF THE COLON. By T. Stacey Wilson, M.D. & B.Sc. (Edin.), F.R.C.P. (Lond.). New York and London: Oxford University Press, 1927.

ALLGEMEINE UND SPEZIELLE CHIRURGISCHE OPERATIONSLEHRE. By Dr. Martin Kirschner and Dr. Alfred Schubert. vol. i. Berlin: Julius Springer, 1927.

SURGICAL MONOGRAPHS. Under the Editorial Supervision of Dean Lewis, A.B., M.D., Eugene H. Pool, A.B., M.D., and Arthur W. Elting, A.B., M.D. Appendicitis. By Hubert Ashley Royster, A.B., M.D. New York and London: D. Appleton and Company, 1927.

LEHRBUCH DER OPERATIVEN GEBURTSHILFE FUER AERZTE UND STUDIERENDE. By Professor Dr. Georg Winter, Prof. Dr. W. Benthin, and Priv.-Doz. Dr. H. Naujoks. Berlin and Wien: Urban & Schwarzenberg, 1927.

CORRESPONDENCE

THE TREATMENT OF OSTEOMYELITIS[1]

To the Editor: In his article on "The Treatment of Osteomyelitis," in the October, 1927, issue of SURGERY, GYNECOLOGY AND OBSTETRICS, Dr. H. Winnett Orr makes the following statement on page 452:

"Delay in providing adequate drainage for the infected bone areas is a common defect in the treatment of osteomyelitis. The teaching has been prevalent that the bones are not to be opened until sufficient involucrum has formed to give strength to the diseased extremity and until complete sequestrum formation has occurred.[2] There is a certain period in the progress of an osteomyelitis when the advice to wait for this condition to come about may be correct. Too often, however, this counsel has been adhered to for many weeks when the patient suffers during the whole period for lack of drainage."

The context in which this paragraph appears conveys the impression that I recommend delay in *acute* osteomyelitis. The conservative methods that I counseled in my article I limited very definitely to *chronic* osteomyelitis. For acute osteomyelitis I, too, recommend prompt and adequate drainage of the bone. And in chronic osteomyelitis I said: "one should provide, if need be, adequate drainage through the soft parts; but if there is no actual sequestrum present, he should delay further procedure until it has developed."

WALTER M. BRICKNER.

New York.

To the Editor: Dr. Brickner has kindly submitted to me a copy of his letter. I regret that I did not make myself quite clear in my article. Dr. Brickner and I are quite in agreement as to the importance of drainage in acute osteomyelitis. My early drainage operation is somewhat more radical than has usually been recommended.

It is precisely in the early chronic case, however, that I recommend extensive drainage (before sequestrum formation), especially if the patient is running a septic course. There need be no delay for the formation of sequestrum or involucrum; indeed, that entire process, septicæmia and the whole series of late osteomyelitis symptoms and sequelæ may be avoided. Then, following the drainage operation if the diseased part is carefully immobilized in correct position and the wound let alone so that there is neither direct nor indirect secondary or mixed infection, the patient will have a short and uncomplicated convalescence.

H. W. ORR, M.D.

Lincoln, Nebraska.

[1] Submitted September 17, 1927.

[2] Brickner, W. M. Attenuated bone infections. J. Am. M. Ass., 1925, December 5.

TWENTY-FIVE THOUSAND FOUR HUNDRED TWELVE PLUS STONES IN ONE GALL BLADDER

To the Editor: What is the largest number of gall stones removed at one operation, is a question; a number of years ago, after removing over 4,000 in one case, I looked the matter up to a limited extent and have been under the impression that I found a record of 17,000; but recently, in looking the matter up again, I was unable to verify that impression. Most writers content themselves with the statement that the stones may vary in number from one to "hundreds."

Moynihan, in his work on "Gall Stones," reports 1,885 as the largest number that he himself had ever removed, these stones being of the average size of a "mustard seed." He credits Frerichs with 1,950; Dunlop with 2,011; Hoffman with 3,646; Langenbuch with 4,000; Naunyn with 5,000, and Otto with 7,802.

August 10, 1927, Mrs. D. S., age 39; mother of seven children, the youngest aged 5 years; presented herself with a large amount of pelvic pathology and also with the usual symptoms of disease of the gall bladder. At operation next day (an abdominal panhysterectomy), examination of the gall bladder showed it to be quite large and to contain many stones. Nine days later, the patient being in excellent condition, I did the usual cholecystectomy. The gall bladder was found thick walled, filled with thick bile and containing innumerable gall stones. Large numbers of these stones, under the supposition that they were merely "sand," were lost in freeing them from the tenacious bile, but a count of those that were saved gave a result of 25,412. Probably not less than 5,000 had been thus lost.

These stones vary considerably in size; all are round and of a uniform brown color with a polished surface as though varnished. The larger have a diameter of one-eighth inch, and the smallest a diameter of about one-half that, but examination of the smallest with a reading glass shows each to be a perfect gall stone, precisely like the larger ones except in size.

The patient made an uninterrupted recovery.

J. F. BALDWIN.

Columbus, Ohio.

SUTURE OF THE FACIAL NERVE WITHIN THE TEMPORAL BONE

To the Editor: In the July, 1927, issue Dr. Sterling Bunnell of San Francisco published an article on "Suture of the Facial Nerve within the Temporal Bone" with a report of a first successful case.

In May, 1922, Dr. K. Winfield Ney of New York City published in the *Laryngoscope* the technique of an operation for the direct repair of the facial nerve, entitled "Facial Paralysis and the Surgical Repair of the Facial Nerve." This procedure is a repair of the facial nerve in the facial canal, with a technique similar to that referred to by Dr. Bunnell. Previous to publishing this article, Dr. Ney had successfully operated upon three cases of facial paralysis in which he used this technique. Since then he has operated upon many others. I have personally observed a number of these operations and have witnessed in a number of patients a complete restoration of co-ordinated emotional facial function.

JAMES CRAIG JOYNER, M.D.
New York.

URETERAL STRICTURE, ITS ANATOMICAL AND PATHOLOGICAL BACKGROUND

To the Editor: As a result of recent publications, apparently coming from my service at the Mt. Sinai Hospital, New York City, the impression has gained ground that I have changed my attitude, as frequently expressed, concerning strictures of the ureter as described by Dr. Guy Hunner of Baltimore.

The publication in the October number of SURGERY, GYNECOLOGY AND OBSTETRICS of the work done in Germany by Dr. Martin Schreiber has no connection with the clinical study as carried out on my service at Mt. Sinai Hospital. The fact that it was published with my name figuring rather prominently at the beginning of the article has given numerous gentlemen who are interested in urology the impression that these studies incorporate my present viewpoint.

There is no need at the present moment for me to analyze this publication nor to point out the discrepancies between this work and that of Dr. Guy Hunner.

In view of the fact that this paper was presented before the Academy of Medicine in New York, at which time Dr. Thomas J. Kirwin also contributed a paper and Dr. Guy Hunner opened the discussion, it seems only proper to draw attention to my part of the discussion which took place that night and which was published in the *American Journal of Surgery*, p. 59, July, 1927. In this discussion, I ended my remarks: "I must conclude that I am as yet not convinced that he (Dr. Guy Hunner) has proved his point that strictures are very common, that they are bilateral usually, that they are due to local infection, that they can be recognized regularly by the wax-bulb hang, and that the ureter behind the stricture does not have to be dilated."

New York. EDWIN BEER, M.D.

MEDICAL STUDY IN BERLIN

The American Medical Association of Berlin furnishes to American medical students, practitioners, and scientists any needed information concerning medical science courses, hospital and laboratory work in Berlin.

The officers of the association are in contact with all activities of the hospitals, clinics, and the University of Berlin Medical School, and they invite correspondence concerning the opportunities for medical study, cost of living, etc.

AMERICAN MEDICAL ASSOCIATION OF BERLIN.
c/o Kaiserin Friedrich-Haus,
Luisenplatz 2-4,
Berlin NW6.

AMERICAN COLLEGE OF SURGEONS

CELEBRATION OF LISTER CENTENARY

PRESENTATION OF REPLICAS OF THE LISTER EXHIBITION[1]

By HENRY S. WELLCOME, Esq., London, England
Honorary Fellow, Royal Society of Medicine

IN HISTORIC calendar records, the year 1927 will be memorable as the Centenary Anniversary of the birth of the immortal Lister.

Lord Lister's indefatigable research work and epoch making discoveries in the field of surgical science have brought immeasurable benefits to mankind.

From the beginning of time, it has been the foremost aim of Good Samaritans to relieve pain and to postpone death. Toxic bacteria, life's most deadly enemy, infinitely minute, invisible and irresistible, held sway through the ages and ever defied the master minds of the healing art. In spite of great advances in surgical science, deadly germs until recent times eluded detection and control.

Pasteur's bacterial discoveries greatly influenced Lister in his memorable work, which lead to his historic achievements in antiseptic surgery. Lister fully acknowledged his indebtedness to Pasteur.

In London, England, April last, a great International Centenary Lister Celebration was held. Delegates from all parts of the world attended. As the chief repository of Lister historical material, the Historical Medical Museum was made the Official Exhibition of this Celebration.

During his life, and since his death, this Museum has acquired many personal relics and an extensive collection of items used by Lord Lister and associated with his research work.

Several years ago the scientific world was shocked by an announcement that the Royal Glasgow Infirmary where Lister had conducted his researches and made his historic discoveries, was, for economic reasons, to be torn down. Regardless of world-wide protests from leading scientists, the local committee in control, persisted in their purpose. House breakers were called in and demolition of the building begun. Then, through the aid of friends and associates of Lister, we succeeded in securing an important section of the original Lister Ward in the Royal Glasgow Infirmary, together with its original fittings, furnishing and equipment. These were transferred to London and now form the center of the Lister Collection in the Historical Medical Museum,

Early this year, several distinguished officials of the American College of Surgeons notified me of the intention to hold a Lister Centenary celebration in America, and requested me to aid them in their project.

It gave us great pleasure to respond with an offer of the collection of replicas now on view in the American College of Surgeons Lister Centenary exhibition, and intended to form a permanent exhibit in the Museum of the College. An exact model of the original Lister ward is included in this collection.

This collection is listed in the descriptive catalog supplied by the Historical Medical Museum. I desire to say that the members of my Museum staff carried out the preparation of this collection with the utmost zeal and enthusiasm, having special regard to its destination and purpose.

Special credit is due to Mr. Malcolm, conservator of the Museum who directed and supervised the work.

It seems to me most natural and appropriate that the American College of Surgeons should receive the co-operation of the Historical Medical Museum of London. Both institutions were organized and born in the same year. Sir Rickman Godlee, nephew of Lord Lister, and himself a very distinguished surgeon, was then president of the Royal College of Surgeons, London. He was one of the Godfathers of the American College of Surgeons. Furthermore, Sir Rickman gave interested co-operation in the organization of the American College. Likewise, Sir Rickman Godlee, in the same year, was one of the Godfathers of the Historical Medical Museum, London, and gave interested cooperation in its organization.

In the last section of the descriptive catalogue, is a brief excerpt from the speech of Sir Rickman, when he assisted at the inauguration ceremony of the Museum.

[1] Presentation made at the Clinical Congress of the American College of Surgeons, Detroit, October 4, 1927.

Section of the original Lister Ward from the Glasgow Royal Infirmary. Wellcome Historical Medical Museum.

Another link in the affiliation between the American College of Surgeons and the Historical Medical Museum is the Great Golden Mace inscribed: "From the Consulting Surgeons of the British Armies to the American College of Surgeons in Memory of Mutual Work and Good Fellowship in the Great War, 1914-1918."

Mr. President, the original Great Golden Mace, rich in profoundly significant emblemism, rests on the pedestal before you.[1] At the time of the presentation of this Mace to the American College of Surgeons, leading British Surgeons requested me to commission the sculptor of this remarkable example of Goldsmith's craft to execute an exact replica, to remain in England. That replica was wrought with fidelity and rests in the Hall of Statuary at the Historical Medical Museum, London.

While the American College of Surgeons hold the original Mace, as a sacred reminder, the Historical Medical Museum holds the replica as a reminder, equally sacred.

Of the Lister Collection, the American College of Surgeons now holds the replicas and the Historical Medical Museum holds the originals. Both collections will, I trust, serve as reminders of mutual good will, endeavor and co-operation in the promotion and advancement of the sciences of medicine and surgery.

[1]For complete description of the Great Mace see Surg., Gynec. & Obst., 1920, xxxi, 648-650.

I would like to mention one of my many personal obligations to America and American surgeons. One of my most valued preceptors, and the one who, in my youth, inspired and guided me in my studies, and insisted on my qualifying myself for a career in the field of science, was that great pioneer surgeon in the West, Dr. William Worsley Mayo, the father of those two gifted surgeons, William and Charles Mayo, who have earned world-wide renown by their scientific achievements.

Mr. President, I beg you to accept this offering for the American College of Surgeons from the Historical Medical Museum of London.

THE president of the College, Dr. George David Stewart, accepted the replica of the Lister Exhibit, in behalf of the officers and Fellows of the American College of Surgeons, and the following resolution of thanks was authorized by the Board of Regents:

WHEREAS the Wellcome Historical Medical Museum, through the kindness and generosity of Mr. Henry S. Wellcome, its Founder and Director, has presented to the American College of Surgeons a replica of the Lister Collection in the Wellcome Museum in London, and

WHEREAS Mr. Wellcome has so generously presented to the College for distribution copies of the descriptive catalogue of the Lister Exhibit, and

WHEREAS this exhibit was the outstanding feature of the Lister Centenary celebration of the American College of Surgeons held in conjunction with its Clinical Congress in Detroit, October 3 to 7, 1927,

THEREFORE BE IT RESOLVED that the appreciation and thanks of the officers, Regents, and Fellows of the American College of Surgeons be transmitted to the Wellcome Historical Medical Museum, and to its founder and director, Mr. Henry S. Wellcome, for this timely gift, which is to have a place in the museum of the College, where it will serve as a constant reminder to the Fellows and all visitors of the outstanding achievements of Lister, "the Founder of Scientific Surgery," and the great debt which they owe to him for his epoch-making discoveries, and

BE IT FURTHER RESOLVED that the thanks and appreciation of the officers, Regents, and Fellows of the College be transmitted to the staff of the Wellcome Historical Medical Museum for their zealous and enthusiastic work in preparing the Lister collection and the descriptive catalogues, and

BE IT FURTHER RESOLVED that the Director General of the American College of Surgeons be asked to transmit a copy of this resolution to Mr. Wellcome and to the Wellcome Historical Medical Museum.

PRESENTATION OF THE LISTER MEMORIAL TABLET[1]

BY HORACE G. WETHERILL, M.D., MONTEREY, CALIFORNIA

THE Western Surgical Association was organized in 1891—thirty-six years ago—and a few of the older members of that organization, who are still living in the enjoyment of its fellowship and happy associations, had been engaged in the practice of surgery for some years previous to that time. They were familiar with the conditions under which surgery had been done before Lord Lister's teachings had been accepted and generally adopted, and, in consequence, they are today in a position to compare the then with the now and to appreciate what Lister's fundamental discoveries have meant to surgeons, to surgery, and to mankind.

No compilation of historical data, no traditions of the horrors of the surgery of the past, can convey a true and impressive picture that will give succeeding generations an adequate understanding of the real significance and importance of the transition from the old surgical art to the new surgical science.

Lucas-Championnière tells us that there are only two periods in surgery: that before Lister, and that since Lister.

Most of the surgeons of the twentieth century accept modern surgery as taught and practiced today as a matter of fact. They take it as they find it without giving much time or thought to its antecedent history or the evolutionary growth that has made it what it is today. Many are, therefore, without a true realization of what they owe to Lister and to the development of modern scientific surgery founded upon the discoveries and teachings of Pasteur and Lister. They, like the profligate son of a too prosperous father, forget that all they have and are or ever hope to become, they owe, primarily, to him.

The Fellows of the Western Surgical Association, particularly some of "the old guard," who remember the days of putrid and sloughing stumps, septic silk ligatures and sutures, and streams of "laudable pus," which can never be effaced from memory or totally wiped away from a retentive olfactory sense, know and appreciate what Listerism has meant to mankind.

The epidemics of pyæmia, erysipelas, hospital gangrene, tetanus, sepsis, and puerperal fever, that once decimated the hospitals of the pre-Listerian period, are no more. Clean, dry wounds and primary union are the rule rather than the exception, and surgery has become the inviting field for the many instead of the unpromising and disheartening vocation of the few who dared its dangers and discouraging difficulties.

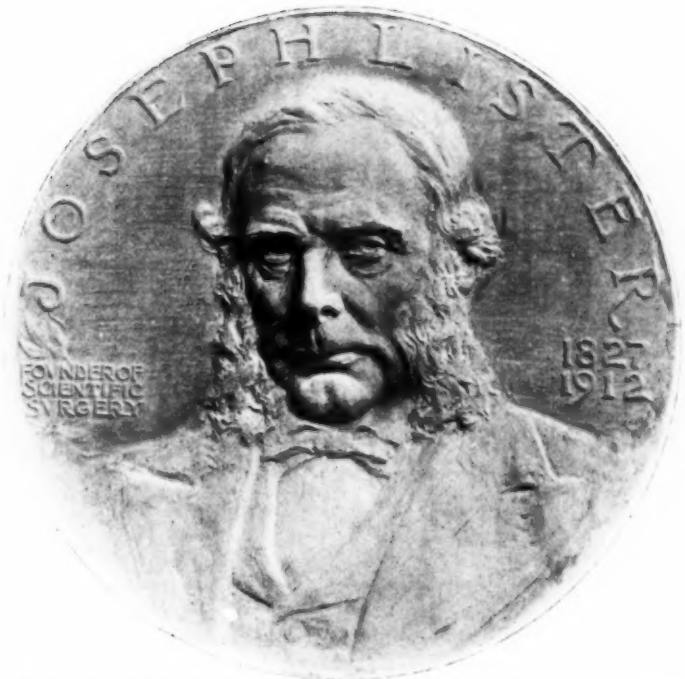
It is a rare privilege to have lived through this transitional period of modern medical and surgical development and some of us who have enjoyed that privilege are glad to have the opportunity to give expression to our gratitude to one who has made it possible.

As an evidence of the appreciation of the Fellows of the Western Surgical Association, and as a slight token of the great obligations we all owe to Lord Lister, this memorial tablet, designed and modeled with exceptional artistry by Mrs. Julia Bracken Wendt, was brought into being.

In casting about for a place in which our memorial should find a fitting environment, it was decided by the executive council of the Western Surgical Association, that the Murphy Memorial Building of the American College of Surgeons would be the most appropriate place in America to give it a proper setting.

It was, therefore, offered to the Regents of the American College of Surgeons, and was accepted by them for the College with the understanding that it is to be given a place in the Murphy Memorial building.

[1]Presentation made at the Clinical Congress of the American College of Surgeons, Detroit, October 4, 1927.



Photograph of Lister memorial tablet (heroic size) presented by the Western Surgical Association to the American College of Surgeons, at the celebration of the Lister centenary, Detroit, October 4, 1927.

As the Chairman of the Lister Memorial Committee of the Western Surgical Association, I have, therefore, the honor to present, in behalf of our Fellows, to you, Mr. President, as the representative of the American College of Surgeons, this memorial tablet in commemoration of the epoch-making discoveries of Joseph Lister, "The Founder of Scientific Surgery."

This is our tribute to a benefactor of mankind. It is given in the centenary year of his birth, and we bestow it upon you with a reverent regard for the man and a deep appreciation of the work he did. We entrust you with it in the hope and with the belief that it will find in your keeping an honorable and appropriate setting.

Mr. President—Doctor Lewis H. McKinnie, president of the Western Surgical Association, will unveil our memorial to Lord Lister.

IN behalf of the officers and Fellows of the American College of Surgeons, its president, Dr. George David Stewart, accepted the Lister Memorial Tablet, and the following resolution of thanks was authorized by the Board of Regents:

WHEREAS the Fellows of the Western Surgical Association, as a token of their great obligations to Lord Lister, have made possible the execution of a tablet to his memory, designed and modeled with exceptional artistry by Mrs. Julia Bracken Wendt, and

WHEREAS this Association has selected the American College of Surgeons as the recipient of the Lister tablet, and the Murphy Memorial building of the College as the fitting environment, and

WHEREAS this tablet was one of the outstanding features of the Lister Centenary celebration of the American College of Surgeons, held in conjunction with the Clinical Congress of the College in Detroit, October 3 to 7, 1927,

THEREFORE BE IT RESOLVED that the thanks and appreciation of the officers, Regents and Fellows of the College be transmitted to the Executive Council of the Western Surgical Association, and to its Fellows, for their kindness and generosity in preparing this beautiful and timely gift which will serve as a constant reminder to the Fellows of the College and visitors of the outstanding achievements of Lister, "the Founder of Scientific Surgery," and the great debt which they owe to him for his epoch-making discoveries, and

BE IT FURTHER RESOLVED that a copy of this resolution be transmitted to the Fellows of the Western Surgical Association, through its president, Dr. L. H. McKinnie, who unveiled the Lister tablet, and to Dr. Horace Greeley Wetherill, who, in behalf of the Association, presented the tablet to the American College of Surgeons in Detroit on the evening of Tuesday, October 4, 1927.

SOME PERSONAL RECOLLECTIONS OF LORD LISTER[1]

By W. W. KEEN, M.D., LL.D., PHILADELPHIA
Emeritus Professor of Surgery, Jefferson Medical College; Doctor, Honoris Causa, University of Paris; F.A.C.S. (Hon.)

PERSONAL recollections of such a great benefactor of the whole human race, who, with Pasteur and Koch revolutionized modern surgery after twenty-four centuries of groping progress, are always worth recalling. I make, therefore, no excuse for these few and slight contacts with this great yet modest surgical hero.

My first personal contact with Lister was at the International Congress of Medicine in Philadelphia, in September, 1876. It was not one of the regular triennial congresses, but met at the call of the medical profession of the United States in connection with our celebration of the Centennial of our National Independence. Europe participated with us to some extent. Especially should we remember with gratitude the wholehearted collaboration of Great Britain in the wonderful exhibition and the Medical Congress. How generous it was for the British, who had been defeated in the Revolutionary War, to help us, the victors, so liberally in celebrating our victory and their own defeat. The British delegation was by far the largest and the most distinguished. I need only name Lister, who was then president of the Royal Society, Lauder Brunton, William Adams, the younger Simpson, Brudenell Carter, Argyll Robertson and Hingston of Montreal as examples.

Our surgical nestor, Samuel D. Gross, was elected president of the Congress and Dr. I. Minis Hays and myself were two of the general secretaries. Of course, Mr. Lister (as he then was), the successor of Syme in the chair of surgery in Edinburgh, was elected president of the surgical section. The chief event of the whole Congress was Lister's address and the following debate on antiseptic surgery.

His first paper on antiseptic surgery had been published when he was professor of surgery in Glasgow in 1867—nine years before our Congress. But on account of the cold reception of his new method by the British surgeons and the British medical journals, it had not attracted much attention in the United States.

No better illustration of the skeptical attitude of the English speaking profession could be cited than Erichsen's *Surgery* which was, from 1853, the classic surgical text book in English speaking countries for thirty years. Several editions were reprinted in America and the work was translated into several foreign languages.

Lister's emphasis was always upon the septic germs in the *atmosphere* as the chief danger to be guarded against by means of a spray of a solution of carbolic acid. Not only one spray apparatus was recommended but two or even three, if so many were necessary to cover the whole field of operation. At first hand sprays were used; later steam spraying apparatus, as you have seen in the remarkable exhibit of the "Welcome Historical Medical Museum."

"One single septic germ in a wound," said Erichsen, "would light up all the mischief." He overlooked the beneficent work of dear old Mother Nature.

Though he praised the antiseptic system calling it "as novel as it is scientific" yet in the two later editions of 1873 and 1878 he expressly declares "theoretically it is perfect; in practice its success is not constant."

In the edition of 1873 he even prints an illustration of the best method of introducing a seton into an abscess! I venture to say that not one of us has used a seton during the past 40 years.

I confess with shame now that I knew only the fact that Lister had introduced a new method of wound treatment by carbolic acid and that his system had been rejected by most British and American surgeons.

How primitive the conditions of travel as well as of surgery in 1876 were, is shown by the fact that Lister crossed in a then famous Cunarder the "Scythia" which had all sails set as well as her engine, yet she only made fourteen to fifteen knots for the wind had split her mainsail and delayed her arrival.

In his presidential address on antiseptic surgery to the Surgical Section, Lister spoke for 2½ hours and another hour was devoted to replying to questions.

The debate which followed his address was singularly one-sided.

The "Spirit of St. Louis," however, then first burst forth, for that excellent St. Louis surgeon, John T. Hodgen, in opening the debate on antiseptic surgery advocated Lister's method. But he spoke chiefly of "germs," "catalytic germs," and "germinal matter," and contended that in tissues far removed from any possible contact

[1]Read before the Clinical Congress of the American College of Surgeons, in Detroit, October 4, 1927.

with germs, putrefaction occurred. He advocated all means to exclude the germs. Frank Hamilton of New York and Kinloch of Charleston spoke in moderate commendation of Listerism. Others totally rejected the theory of the origin of putrefaction from germs, and still others doubted the effect of the spray on intestines exposed to it in operations for hernia, ovariotomy, etc.

The autocratic claim of Listerism as the only method was disputed, and chlorine and "perfect cleanliness" and rest were asserted to be "just as good." But we men of 1876 knew nothing beyond what I may call "soap and water cleanliness" and not Listerian cleanliness. We did not recognize till later that death lurked under our finger nails, in our silk ligatures, on our dressings, on the skin of the patient, etc. Even in 1882 and 1883 in the American Surgical Association speakers manifested their disbelief in the bacterial origin of infection. Under the influence especially of Liebig, oxygen had been deemed to be the cause of putrefaction. It required time, experimentation and the experience of repeated disasters following our old methods contrasted with the wonderful antiseptic successes, to convince the surgical world of the value of Lister's principles.

I took no part in the debate for I knew far too little of antisepsis to warrant even a word. But the result was my firm conviction that Lister was right. I became in practice his first disciple in Philadelphia.

On October 1, 1876, when I went on duty at St. Mary's Hospital, I found no means for practicing the antiseptic method. I collected the special dressings, an atomizer to fill the air with a carbolic atmosphere and the protective and other materials needed in the complicated ritual of that day. Later, a wider knowledge abolished the spray, especially when some of the surgeons and patients, from prolonged inhalation of carbolic acid, suffered from hæmaturia. From constantly washing them in carbolic solutions our hands soon looked ragged from the peeling epidermis, like the old white birch bark of the forest.

Our progress was truly *per aspera ad astra* until today you know well how simple and how soul-satisfying is our surgical technique.

I was Washington Atlee's second assistant for some years and that foremost ovariotomist saved only one out of three of his patients and I heard my professor of obstetrics at the Jefferson declare that ovariotomists "should be indicted for murder."

Repeatedly I have heard the elder Gross say to the orderly, "Hughey, tomorrow I am going to lecture on 'suppuration'—go to the hospital"—a small affair of not over a dozen beds—"tomorrow morning and get me a half tumbler of pus." Pus was always "on tap." What a contrast to today, when you have to hunt for it, and usually without success.

Secondary hæmorrhage was very common. In the Civil War out of 2,235 cases, 1,433, 61 per cent, died as a result and many additional cases doubtless escaped being recorded. Ten days after the Battle of Gettysburg when I was on duty as "officer of the day" in the hospital, I was called to five cases of secondary hæmorrhage in that single night. Never in all the thirty-one years of my later active surgical life did I see so many secondary hæmorrhages as on that one night. That tells the story! In the same war there were reported 2,818 cases of pyæmia of whom 2,747, 97.4 per cent, died. Does it not make your blood run cold to imagine such fearful results of pre-Listerian days?

Primary healing was an occasion of boastfulness, while today, the lack of primary healing is a reproach to any surgeon.

Such heart-breaking tragedies often made the surgeon wish he were a hod-carrier or even in his grave.

Thank God, such tragedies are now but specters of a horrid and vanished past.

How felicitous was Harvey Cushing in his notable address at the Lister Celebration in Edinburgh when he described Lincoln and Lister as the two greatest "Emancipators!" The one freed millions from legal life-long slavery; the other emancipated all mankind from Infection, its most deadly surgical enemy.

How slow our progress was may be estimated from the following facts. From 1850 when Davaine merely noticed in the blood the little rods of anthrax as an observed but curious fact, to 1882 when Koch first discovered the bacillus of tuberculosis, had sufficient bacteria been discovered to allow of sorting them out and their orderly classification, and, therefore, warranted the addition to the English language in 1884 of the word "Bacteriology."

Look at our modern statistics as to ovariotomy, compound fracture below the knee, which Syme and most conservative surgeons formerly treated by amputation as the less dangerous alternative, and recall our many other daring operations of today.

On the head, chest, and abdomen *nɔli me tangere* was writ in large letters, unless these cavities had already been opened by accident or disease.

Per contra, some years ago I declared that the abdomen might now be cal'ed the "playground of

the surgeon" so free were we in our license to open it, and operate successfully on any of its many important organs.

The same might also be said of the head and the heart. We can now irrigate the lateral ventricles of the brain from side to side, and Cutler has lately shown us how to operate on the valves inside of the heart itself. All of this progress harks back to Lister's remarkable work, and to Pasteur, his fertile and wonderful predecessor.

We also believed, as taught by Flourens, that the brain acted as a unit, like the liver or the kidneys, until Fritsch, Hitzig, Ferrier, Horsley, and others showed us that in the brain various regions were strictly localized, with many special centers for motion, vision, audition, etc. The earliest "localization of function" in the brain was Broca's center for speech, located by clinical and postmortem evidence, in the third left frontal convolution of the brain. This is the only "center" which has not been discovered by experimentation upon animals, and verified by many operations on man. So accurate is this localization that in one case the removal of a cube of grey matter one quarter of an inch in size paralyzed all the nine muscles moving the thumb, and not another muscle.

We can open knee joints, do what we wish, and close them again without any assured following infection requiring a frequently fatal amputation.

Amputations of the breast now heal within a short time instead of weeks and months. We laugh at the worry and the sleepless nights of Sir Astley Cooper, as related in his *Life* by his nephew Bransby Cooper, before he removed a simple wen from the head of the King, lest erysipelas and death should follow. Yet that was an ever prevalent danger, especially about the head, before Lister's day.

All aseptic wounds are healed quickly and without what had been formerly, and appropriately, called "surgical fever," for, in the earlier days, all operations were followed by fever as an expected and a constant result, and not seldom also by death.

Dr. J. Ewing Mears followed me in St. Mary's Hospital, January 1, 1877, and he and every one else on the staff continued the antiseptic treatment initiated in St. Mary's Hospital on October 1, 1876.

My second personal contact with Lister was in 1907. I knew that his 80th birthday would occur on April 5. I reached Berlin on April 1 and stayed in the Hotel Continental. The annual meetings of the German Surgical Society are always held in the Spring and as I had just resigned at the Jefferson in January, on my 70th birthday, it was my first opportunity to attend the Congress of which I had been elected an Honorary Fellow while in India in 1902.

I wrote to Lister from the hotel a letter of congratulation, adding that I well knew that I was but voicing the unanimous American appreciation of his wonderful contributions, not only to surgery, but to the welfare of the whole human race in nearly every department of medicine, and also to animals.

On his birthday I received a brief holograph letter of thanks for my letter.

About a month later, fearing that I was a temporary traveler at that hotel and might easily have passed on and never have received his reply, I received a second four page holograph letter sent to my Philadelphia address, thanking me for my kind congratulations. Godlee's *Life* records that on his birthday he was "overwhelmed with letters and telegrams from all over the world," yet this courteous gentleman, as he ever was, took time to send this second and longer holograph letter lest his first one should have failed to reach me. What a pattern for our whole profession.

My third contact was again through a famous letter.

In 1900 in Washington we had a "Field-Day" over vivisection. Senator Gallinger of New Hampshire, had an M.D degree and had practiced for a time, but then abandoned medicine for politics. He had introduced a bill prohibiting experiments on animals in the District of Columbia and all the national territory in the Philippines, Porto Rico, etc., which, if passed, would be a long and powerful lever for a similar prohibition with all state legislatures. Each side marshaled its forces for a pitched battle. Our leader was Dr. William H. Welch of Johns Hopkins. Bishop Wm. Lawrence of Massachusetts came from Boston and helped mightily. On April 4, 1898, Lister in response to my request had sent me a 3½ page foolscap holograph letter setting forth his experience and opinions as to experiments on animals. At my request Dr. William H. Welch put this letter in evidence before the Committee and it was published in full in their report. It had great weight with them.

The original letter I have given to the College of Physicians. It has been placed in the vault. A photostat copy between double glass plates swings in a frame in our Library, with a note telling its history.

The bill was killed. A year or two ago a similar one was easily killed chiefly by the influence of the local profession in Washington.

An appreciation of Lister's marvellous work has been a part, and I may truly say the most influential part, of the forces of scientific surgery which brought about its victory—now practically conterminous with the surgical world—the greatest revolution in surgery since the days of Hippocrates, 24 centuries ago. Many others, expecially in England, Germany, and France (not forgetting the able part played especially by Kocher in Berne) soon followed. After 1876 the battle was soon won with the vast majority of English speaking surgeons. Today only a few older and ill informed surgeons are still unconvinced.

Instead, also of chemical antisepsis, we learned that prolonged exposure to heat and wide disinfection of the skin of the patient by iodine, and surrounding the field of operation by disinfected sheets and towels, created an *aseptic area*, in which it was safe for disinfected hands and instruments to be freely used in the saving of human life and the abatement of human suffering.

When the Great War began we continued this aseptic treatment, but it was soon found that the forces of infection were so extensive and so virulent that our mild asepsis could not cope with them.

Hence the Carrel-Dakin and other methods of continous disinfection replaced our old methods with most satisfactory results.

But all these methods are lineal descendants of Joseph Lister.

Let me urge upon every young and aspiring surgeon to "read, mark, learn" and especially to "digest inwardly" the *Collected Papers of Lister* if he wishes to know that great man and what he accomplished.

In 1902 the Royal Society gave a banquet in honor of the 50th Anniversary of Lister's doctorate. That occasion was made memorable especially by the peroration of the American Ambassador, Mr. Bayard's address in one of his happiest after dinner speeches. Turning toward Lister, who in 1883 had been elevated to the peerage, he said, "My Lord, it is not a Profession, it is not a Nation, it is Humanity, which, with uncovered head, salutes you."

THE FOURTH EPOCH OF MEDICINE[1]

By WILLIAM J. MAYO, M.D., F.A.C.S., Rochester, Minnesota

MEN in every age, in times of spiritual or material stress, have risen to saving intellectual heights, far above the level of their environment. Such a man was Abelard, the dialectic philosopher of the twelfth century, who perhaps has been best known through the great human tragedy of Abelard and Héloise.

The dark ages, which were precipitated by the downfall of the Western Roman Empire, began to lighten in the twelfth century, as manifested by an emotional awakening for which the crusades were largely responsible. The crusaders on their return from the East brought with them the knowledge of the ancient philosophers which fortunately although submerged had not been completely lost. Abelard, Lombard, and other men of the time were leaders of this resurrection of thought and staunchly proclaimed the dictum that understanding is essential to belief, in contradistinction to the controlling ecclesiastic concept that belief is essential to understanding. Their teachings were those of Aristotle, modified to apply to Latin conditions.

From the intellectual controversies of the times sprang the University of Paris under William of Champeaux, founded in the first decade of the twelfth century, to be followed by Oxford University in 1210 and Cambridge University in 1231, the first evidences of systematic education in medieval times.

THE FIRST EPOCH OF MEDICINE

Aristotle was physician to Alexander the Great. When Alexander died at the early age of 33 years, after conquering almost the known world, his empire was divided and Egypt and the Near East were governed by the general, Ptolemy, who established in the capital city named for Alexander on the delta of the Nile, a great museum and library, a treasure house of ancient culture. From Alexandria the Ptolemies ruled Egypt for three hundred years. Cleopatra, immortalized by Shakespeare, was the last of that ill-fated line. The greatest contribution in the first epoch of medicine was made by the students of Aristotle in Alexandria who developed scientific methods of investigation.

Hippocrates, a near contemporary, was the first to apply Aristotle's methods of reasoning to the treatment of disease, and he it was who

[1]Lister address read before the Clinical Congress of the American College of Surgeons, October 4, 1927, Detroit.

inaugurated the struggle against medical superstition which continues to this day. The aphorisms of Hippocrates are known to every medical student; the Hippocratic oath is a condition of fellowship in the American College of Surgeons. Is it any wonder that rational methods of investigation as laid down by the Aristotelian school in the Ptolemaic era should have controlled scientific thought in medicine for two thousand years?

That great breach in the church which occurred in the fourteenth century was perhaps most marked in England. The medieval period brought a spiritual and emotional change to the people, led by a militant church, evidences of which remain in the ruins of magnificent old abbeys and castles. The division brought about by the leaders of the Reformation led to the great schism which enabled Henry VIII, of unsavory memory, to establish the Church of England with himself as head. To Henry VIII belongs at least the credit of establishing at Oxford University in 1546 the first medical school in England.

THE SECOND EPOCH OF MEDICINE

The reign of Elizabeth, daughter of Henry VIII, may be called the most illustrious of all periods of the world's history. The great mental and moral disturbances of the times led to a spirit of investigation which freed the intellect from dogma. In the realm of discovery and conquest a brilliant figure was the buccaneer, Sir Francis Drake, who was the second to circumnavigate the known world, and whose nautical skill defeated the Spanish Armada. Literature in this period was enriched by Shakespeare's gift of his great dramas, which have never been equaled.

Science, which had depended for twenty centuries on the primitive methods of the deductive logic of Aristotle, received a new impetus through the development of the inductive logic of Francis Bacon, and scientific imagination developed, resulting in the building of images to be compared with known facts. This new logic added greatly to scientific resources; it enabled William Harvey, who had studied anatomy at Padua under Vesalius, Fabricius, and Casserius, to demonstrate the circulation of the blood. We think of Harvey only as the discoverer of the circulation of the blood, but his work reached far beyond the elucidation of isolated facts. Harvey was an anatomist as well as a physiologist. He recognized that one purpose of the pericardium was to protect the heart from bursting during violent physical strain; he recognized that the peculiar twisting motion of the heart was to enable its cavities to empty themselves of the blood they contained, as a wet cloth is freed from water by wringing. All of the scientific undertakings of Harvey were characterized by the same logical association of facts that he manifested in his observation of the circulatory system. He was the founder of organized experimentation and research in medicine, and when necessary used vivisectional methods in controlled experimentation to parallel clinical experience.

Sydenham, of precious memory, was the clinician of Harvey's time, and what Hippocrates was to Aristotle, Sydenham was to Harvey. Sydenham, with a clear mind and a hatred for sham and hypocrisy in medicine, gave us the finest insight of all time into clinical medicine as related to current knowledge. While we look on him as the proponent of sound theories of the causation and classification of fevers, this investigation was merely one expression, and that almost incidental, of his clinical acumen, which led to many advances in medical science.

The second epoch of medicine produced another man about whom we have heard little, John Mayow, one of the first of the physician chemists. The observations and experiments of Mayow led to the discovery of oxygen, and now, after nearly three hundred years, we are just beginning to understand those fundamental problems which connect physicochemistry with the medical sciences. The impetus given by the work of Harvey, Sydenham, and Mayow led to rapid advances in knowledge of the sciences in relation to clinical medicine.

During this fertile age came the first crude form of the microscope, introduced by the Janssen brothers in 1590, the most significant scientific contribution of all time, which was destined to revolutionize medicine and to change the history of mankind. This discovery came too late to benefit Harvey greatly, but it gave the hand lens to Hunter and the modern microscope to Pasteur and Lister.

THE THIRD EPOCH OF MEDICINE

Two brothers, William and John Hunter, coordinated knowledge in anatomy, physiology, and pathology so that for the first time these basic sciences became a coherent whole. They put medicine on a sound foundation. The Hunters' greatest single contribution was the discovery of the lymphatic system, as related to the organs and tissues of the body, which in many respects was as far reaching as the discovery of the circulation of the blood, and opened up a vast field of research which is still under way.

William Hunter analyzed the normal functions of life with remarkable understanding, and correlated them by the inductive method. He made many contributions to science, the importance of which, as newer discoveries have proved the acumen of his outlook, has only recently been recognized. Conspicuous among these contributions was the demonstration of the contagious nature of childbed fever.

John Hunter had the divine discontent which leads to progress. He was the first to study pathology as a whole, and it was he who related general pathology to clinical medicine. Previous to Hunter's time great truths were discovered in pathology and medicine, but they were largely isolated and uncorrelated. He originated the Hunterian Museum of the Royal College of Surgeons in London, and prepared 16,000 specimens with his own hands, an illustration of a sound conception of medicine, one hundred years in advance of his time.

The Hunters in their dissections had, owing to the Janssens, the incomparable advantage of a crude form of microscope and the hand magnifying glass which enabled them to follow the course of injections of dyes into vascular and lymph channels. Belchier, of Guy's Hospital, in 1764, had introduced madder dye for this purpose.

Contemporary with the Hunters, and the outstanding figure of the epoch, was Edward Jenner, a country physician, who discovered that inoculation with cowpox prevented the development of the dread scourge of the time, smallpox. John Hunter, who was interested in animal experimentation, writing Jenner in friendly exasperation after attending a meeting at which Jenner had propounded his theory of vaccination for smallpox, without proof, said: "Why submit hypotheses? Try it on a hedgehog and know." From this modest beginning developed the whole fabric of immunization: antitoxin, antitetanin, antivenom, and all the other lifesaving agents of this character now in existence.

Inspired by the work of the Hunters and of Jenner, the spirit of inquiry spread. England became even more firmly established as the center of the medical sciences. Experimentation stimulated vision, and from experimentation came splendid contributions to clinical medicine. From Guy's Hospital alone came the researches of Bright, Addison, Hodgkin, and Fagge, to mention only a few.

In the realm of pure science Brown, the English botanist, first used reflection of light to detect ultramicroscopic objects, the motion of which in the air and in solutions was known as Brownian movements; Dalton promulgated the atomic theory and described "the dance of the molecules"; Graham, master of the mint in London, elucidated Dalton's and Brown's discoveries in the field of colloidal chemistry, and Darwin propounded the theory of evolution which, through its opponents as well as its proponents, has stimulated researches in the animal kingdom, the importance of which, as Keith points out, cannot be overestimated.

In the middle period of medical advancement the microscope had been greatly improved in France, and because of this France became a rival of England in medical science and in the development of scientific medicine.

It is interesting to note that Langenbeck, the father of German surgery, was a student in France and carried back to Germany those beginnings of learning which led to the pre-eminence of Germany in the medical sciences.

THE FOURTH EPOCH OF MEDICINE

In the light of the foregoing sources of scientific stimulation was inaugurated the fourth epoch of medicine, in which two great names are inseparably united in work that stamped out the plagues of infection and communicable diseases. With the advantage of improved microscopes and the development of staining and cultural methods, Pasteur developed his theory of the origin of diseases in micro-organisms and changed the whole aspect of medicine. He applied his knowledge to the salvation of horticulture, in the vineyards of France, and to animal husbandry, in the immunization of domestic animals to the dread anthrax.

Lister had been making extraordinary discoveries with regard to the suppuration of wounds and its prevention before Pasteur's work gave the clue to the cause. Lister, applying Pasteur's discovery to the origin of contagious disease, established the relationship of micro-organisms to infections and putrefactive processes and formulated methods of prevention which were to be the greatest gift made by man to surgery.

On account of the discoveries of Pasteur and Lister, hospitals for the first time became safe. Previously, suppuration and gangrene had caused such a ghastly mortality that patients were actually safer if operated on in the wilderness than in the hospital.

Lister was one of those rare men who was gifted with both originality and practicality. That unusual combination of the investigator and the clinical surgeon, he sought his discoveries in

relation to human need and applied them in a scientific manner.

The culminating contribution of the fourth epoch of medicine has been the wider application of the work of Pasteur and Lister. The diseases that enter the body from without, namely, those caused by micro-organisms, have largely been discovered and classified, and means of destruction of the micro-organisms themselves, or immunization to them, have been discovered or are on the way to discovery.

Dr. Keen, in his inimitable address tonight, has given us glimpses of Lister, the man. I speak rather of the inspirations that have been derived from Lister's work. His undertakings were heroic in conception. They caught the imagination of man and centered on medicine the sympathetic interest of the people of every country.

The medical profession has been reproached for its slowness in accepting scientific discoveries. The physician deals with human life and not with the replaceable elements of industry.

Men in medicine, in spite of limitations, are eagerly studying advances in science which mean so much to the future of the race. The whole fabric of the great advances in biological science in the last generation was woven with microscopy, but the limit of microscopic research has been nearly reached.

The mind of man was built up coincidentally with the eye, and it is this fact and not the mechanics of the eye, that has made intellectual progress possible. Man only has achieved satisfactory results with the visual brain. In the other primates, the apes, monkeys, marmosets, and lemurs, it has dulled the olfactory sense, which controls the behavior of the lower vertebrates, without a satisfactory substitute in the visual sense.

Just as the unaided eye opened the great field of the first and second epochs of medicine, and the microscope in the third and fourth epochs increased the acuity of vision, so have ultramicroscopic methods by tremendously extending vision either directly or by means of mensuration, made possible new and wonderful scientific advances.

The fourth epoch of medicine faces the fifth which lies just ahead. In the fifth epoch achievement concerns the individual and those changes in the tissues which we speak of as metabolic, which lie in the ultramicroscopic field of the colloids, where life itself resides.

AN APPRECIATION OF LORD LISTER[1]

By Sir JOHN BLAND-SUTTON, Bt., LL.D., M.D., F.R.C.S., London, England

SURGERY should interest every living person. Everyone born into this world alive is the subject of an operation—the simplest operation known to surgeons—omphalotomy, which consists in tying and cutting through the navel-string. This simple operation requires a thread, and something with which to divide the cord—scissors, knife, potsherd, a sharp piece of flint or, as in the way of animals, it may be bitten through. Prehistoric midwives probably used for a ligature fiber from plants, bast, tendons from animals, or the legs of birds, or catgut. In pre-Listerian times this simple operation had a dreadful mortality from sepsis, the umbilical vein serving as the channel of infection. Sepsis due to dirty threads and fingers was further encouraged by the time-honored practice of applying cow-dung poultices to promote the separation of the stump. Today, strict measures for avoiding sepsis prevail in the birth-room and there are as many fanciful methods of amputating the placenta, as in excising a pile!

Nothing gave Lister more anxiety in the conquest of surgical sepsis than ligatures.

The most remarkable extension of surgery which ensued on the appreciation of Listerian principles may be covered by the phrase—the surgery of serous cavities: the peritoneal cavity; the meningeal cavities—cranial and spinal; and the serous cavities called joints. Lister did attack joints successfully under carbolic acid precautions. He attempted to invade the abdominal cavity, but failed. Lister's surgical experience had not equipped him to invade the abdomen. Serous cavities will not tolerate strong antiseptic solutions. In my early experience I abandoned carbolic acid in abdominal operations. Lister's principles I followed, but not his methods. Take for example the ancient operation of cæsarean section. In the hands of surgeons up to 1860, this operation was more fatal than the "rough and ready" amputations of the lower limb, but it has been performed successfully by a butcher, by a patient on herself, and by the horn of a mad bull. In each of these three instances the child survived as well as the mother.

Today the cæsarean operation is brilliantly successful when associated with aseptic pre-

[1] Presented at the Clinical Congress of the American College of Surgeons, Detroit, October 4, 1927.

cautions. Signal success in operations on the abdominal organs is not restricted to the few, but is the reward of any careful surgeon trained in modern methods, possessing anatomical knowledge and surgical aptitude.

The extension of intradural surgery has been attended with astounding success as well as an extraordinary increase in an accurate knowledge of the pathology of the central nervous system.

Today, able men are conquering the surgery of the thorax and the vital organs contained in the mediastinum and are supplying that knowledge which Murphy in the preface to the first volume of his *Clinics* in 1912 called *living* pathology! I have already said that Lister was shy of the abdomen, but in the extraordinary progress of surgery he was the pioneer. We do not slavishly follow his ritual but we heartily accept his principles. Toward the end of his life he became a lonely old man and was obsessed with the idea that the younger surgeons were trying to deprive him of credit for antiseptic surgery and give it to aseptic surgery!

Few pioneers in surgery have had the great privilege which Lister enjoyed of seeing his work appreciated throughout the world.

In the last 15 years of his life, I often saw him taking exercise on a summer evening in Park Crescent where he lived and near where his monument stands in Portland Place. In my wildest fancy I never thought that it would fall to my lot to unveil the Lister monument.

March 13, 1924, was a cold dark day, a bitter northeast wind blew and as I ended a short speech saying: "Lister's influence will remain as long as surgery is practiced as an Art and his principles will continue as a blessing on every race of mankind, I pulled the cord—suddenly a glorious flash of sunlight broke through a rift in the clouds and shone on the monument."

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